Myocardial Infarction with Non-obstructive Coronary Arteries (MINOCA) Patients Undergoing Cardiac Magnetic Resonance Imaging (CMR)

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ABSTRACT

Myocardial infarction with non-obstructive coronary arteries (MINOCA) occurs in 10% of patients with myocardial infarction (MI). It is characterised by clinical evidence of MI in whom angiography does not show obstructive coronary artery disease (stenosis severity <50%), and thus there is no immediately apparent cause for the presentation. Cardiac magnetic resonance imaging (CMR) is a key diagnostic tool in the evaluation of patients presenting with MINOCA by providing a definite diagnosis (confirming myocardial necrosis) while also excluding other aetiologies. Despite the recent scientific interest in MINOCA, in clinical practice these patients are often discharged with minimal explanation for their MI diagnosis and limited understanding of their outcomes. To improve this knowledge gap, this study characterises patients presenting with MINOCA according to their CMR findings and describes the prevalence, patient characteristics and 12-month clinical outcomes (readmission and mortality) of those with (i) infarction/myocardial necrosis, (ii) non-ischaemic aetiology, and (iii) normal CMR findings. The null hypothesis to be tested is patient characteristics and clinical outcomes will not vary according to the CMR findings of MINOCA patients. In this retrospective analysis, 941 MINOCA patients were identified through the CADOSA registry between 2012-2017, and 177 underwent CMR. The prevalence of CMR findings were: 9% had an infarct, 70% were non-ischaemic and 21% had a normal CMR. The infarct patients had the highest all-cause, 12-month mortality (6%), followed by the non-ischaemic patients (2%) and 0% for the normal patients. Over 12 months, non-ischaemic patients had the highest cardiac readmission rate (18%), followed by normal patients (14%) and infarct patients (13%). Overall, CMR had a significant clinical impact in 43% of patients by providing a new diagnosis and a specific diagnosis in 79% of patients. These findings highlight the heterogeneity associated with MINOCA patients and clinical outcomes, underscoring the need to individualise their management and follow-up.

Word count: 300

INTRODUCTION

1.1 Coronary Artery Disease (CAD)

Cardiovascular disease refers to heart and blood vessel related diseases such as stroke, peripheral vascular disease and, the most prevalent, coronary artery disease (CAD), which remains responsible for one-third of all deaths in individuals over 35 years.[1] Two major forms of CAD include acute coronary syndrome (ACS) and stable angina.[2] ACS is a collective term for clinical symptoms caused by myocardial ischaemia which includes acute myocardial infarction (AMI) and unstable angina.[2] Patients exhibiting clinical symptoms of ischaemia, but no evidence of myocardial necrosis are considered to have unstable angina,[3] whereas myocardial necrosis (cell death) is indicative of AMI.[4]

1.2 Acute Myocardial Infarction (AMI)

Annually, 55,000 Australians experience AMI or heart attack, which equates to one every 10 minutes.[5] AMI commonly occurs as a result of coronary artery occlusion, ultimately causing haemodynamic disturbance.[6] The pathophysiology of an AMI is reflected by causes of occlusion.[7] Atherosclerosis is a condition in which fatty deposits (plaques) build up along the inside walls of coronary arteries, which reduces the size of the arterial lumen.[7] This restricts coronary blood flow to the myocardium causing prolonged myocardial ischaemia (myocardial tissues are compromised due to inadequate blood flow), ultimately leading to myocardial necrosis.[6, 8, 9] Myocardial ischaemia can manifest as chest pain, termed 'angina'.[10] The atherosclerotic plaques can also suddenly rupture, causing the formation of a blood clot (coronary thrombosis) or vasospasm, resulting in coronary occlusion an thus severe acute ischaemia.[10] Although atherosclerosis is the most common cause of AMI, accounting for at least 70% of fatal events[7, 11] a combination of thrombosis, atheroma and vascular dysfunction also contribute to the pathophysiology of an AMI.[12]

1.2.1 Clinical criteria of AMI

The Fourth Universal Definition of AMI devised by The European Society of Cardiology/ American College of Cardiology Joint Task Force clinically defines AMI by the following features:[6]

a. Positive cardiac biomarker: Detection of a rise/fall of cardiac troponin (cTn) value above the 99th percentile upper reference limit
b. Clinical evidence of MI, including any of the following
    i. Ischaemic symptoms (chest pain lasting >10 mins)
    ii. Ischaemic electrocardiography (ECG) changes

Myocardial necrosis triggers the release of troponin (a protein specifically expressed by cardiac muscle cells) into the systemic circulation.[6] Due to being a sensitive and specific cardiac biomarker of cardiac injury, troponin is considered the 'gold standard' method for assessing AMI, however it is not only used for an AMI diagnosis.[13] Therefore, elevation of cTn must be interpreted in the context of clinical history and ECG findings.[14] Abnormal cTn is considered when values are above the 99th percentile of the upper reference limit.[6] Myocardial injury is defined by elevation of cTn when ischaemia is not present.[14] Distinguished from myocardial infarction, myocardial injury occurs in the setting of cTn elevation in the absence of myocardial ischaemia, and a cause is specified for its presence.[6]

1.2.2 Prognosis of AMI

Patients who survive an AMI are at risk of further cardiovascular events including death, recurrent MI, heart failure, arrythmias, angina and stroke.[15] Prognosis may vary widely between individuals according to their clinical profile, comorbidities and risk factors, thus risk stratification models are important in predicting prognosis.[15] In developed countries, mortality rates following AMI have decreased over time, concomitantly with acute treatment, long-term secondary prevention and the common use of revascularisation procedures.[16, 17] The 30 day mortality after AMI is around 2-3%.[18]

1.2.3 Diagnostic management of AMI

Coronary angiography is an invasive procedure in which a catheter injects a contrast dye into the epicardial coronary artery to establish the site and extent of coronary blockages.[19] Hence, it is the recommended investigation for the identification of coronary artery stenosis related to atherosclerotic CAD, and guides the therapeutic management of AMI.[19] Coronary vessels narrowed at least 50% are termed 'obstructive CAD'[20] which accounts for a significant proportion of myocardial infarcts, hence the term 'MICAD' (Myocardial Infarction with Coronary Artery Disease).[20] The management of MICAD patients is well defined and is focused on alleviating atherothrombotic processes that obstruct coronary blood flow through revascularisation therapies (i.e. stenting) and use of secondary prevention medications.[20]

In the past, patients with a clinical criteria for STEMI (ST-Elevation-MI) were often labelled as having false-positive diagnosis when obstructive atheroma or thrombosis was absent on angiography.[21] Consequently, implying the absence of AMI despite clinical presentation often enabled no further diagnostic investigation or appropriate cardiac therapy.[22] To reduce this diagnostic error, the new clinical entity MINOCA (Myocardial Infarction with Non-Obstructive Coronary Artery Disease) was devised.[22]

1.3 Myocardial Infarction with Non-Obstructive Coronary Artery Disease (MINOCA)

Approximately 10% of patients with AMI do not reveal obstructive CAD on angiography,[23] so the underlying pathophysiological processes are not immediately identified, a diagnosis referred to as MINOCA.[24] This entity has become increasingly recognised through the frequent utilisation of coronary angiography during an AMI ultimately surging a recent interest in these patients.[24] This intriguing subgroup is characterised by clinical evidence of AMI with nonobstructive coronary arteries on angiography (stenosis severity <50%).[20] Potential underlying mechanisms include coronary causes such as plaque disruption and coronary artery spasm; non-ischaemic disorders such

as myocarditis, takotsubo cardiomyopathy (TTC) and other cardiomyopathies.[25] These patients are often discharged with minimal explanation for their AMI, limited therapies and lack of follow-up.[24]

1.4 Types of AMI

The Fourth Universal Definition further classifies AMI into 5 types, outlined below, based on pathological, clinical and prognostic differences, along with different treatment strategies.[6]

Type	Definition
I	Infarction due to ischaemia from a primary coronary event such as atherosclerotic plaque disruption (rupture or erosion).
II	Ischaemic myocardial injury in the context of a mismatch between oxygen supply and demand. This can be caused by coronary spasm, coronary embolism, arrhythmia, anaemia, or hypotension.
III	Sudden cardiac death with symptoms suggestive of myocardial ischaemia, such as new ischaemic ECG changes, but which produces death before a blood sample can be obtained or when death occurs during the lag period before serum markers appear in the blood.
IVa	Infarction resulting from percutaneous coronary intervention.
IVb	Infarction from stent thrombosis.
V	Infarction due to ischaemia related to coronary artery bypass grafting.

MINOCA comprises 5-20% of all type I AMI with atherosclerotic plaque disruption being a frequent cause.[6] It is also important to consider type II AMI as it is the most common cause of MINOCA,[6] such as coronary artery spasm and thromboembolism.[26]

1.5 Clinical Features and Risk Factors of MINOCA

Studies have revealed that MINOCA patients cannot be delineated from those with MICAD based on clinical characteristics or risk factors.[24] Cardiovascular risk factors are similar between both groups, however a comparative study revealed that hyperlipidemia is less likely in those with MINOCA compared to MICAD patients (21% vs. 32% respectively).[25] In comparison to those with MICAD, MINOCA patients are younger and more often women (40% vs. 25% respectively), despite sharing

many other clinical features.[25] More specifically, 55 years was calculated to be the mean age of MINOCA patients while MICAD patients typically range between 58.8 and 61.2 years.[25]

1.6.1 Diagnosis of MINOCA

A MINOCA diagnosis is made for patients with a clinical presentation of AMI (according to the Universal Definition aforementioned)[6, 27] in whom angiography does not show obstructive CAD and there is no immediately apparent cause for the presentation.[24] This is an important distinction to make, as AMI is a clinical diagnosis, some patients may have fulfilled criteria for AMI but may have experienced a disorder that 'mimics' AMI.[24] A common example of this is myocarditis (inflammation of the heart muscle, often caused by a virus) where a patient can present with fever, pleuritic chest pain, ECG changes and troponin elevation.[24] In this situation, an angiography is performed to rule out CAD and reveals non-obstructive CAD.[24] The diagnosis is myocarditis and the patient should not be considered MINOCA.[24] In contrast, a patient with no virus symptoms or fever who presents with pleuritic chest pain, ECG and troponin elevation and reveals non-obstructive CAD should be diagnosed as MINOCA.[24] It is in this context that MINOCA is considered a 'working diagnosis', analogous to heart failure.[26] This flags the necessity to evaluate the patient for the potential underlying cause of this presentation.[24]

1.6.2 Using Cardiovascular Magnetic Resonance Imaging (CMR) in MINOCA

Given the range of aetiologies that can account for MINOCA presentations, further investigation to identify underlying causes is important if effective therapy is to be instituted.[24] The characterisation of myocardial and microvascular injury in MINOCA patients can be completed by CMR.[28] The high tissue contrast and resolution of this diagnostic tool allows for precise evaluation of myocardial structure and function.[6] Late gadolinium enhancement (LGE-CMR) uses contrast agents for the assessment of myocardial perfusion and prior MI (increase in extracellular space associated with the fibrosis).[6] As little as 1 gram of subendocardial infarction can be detected by localised delay in

contrast enhancement.[29] CMR is also able to determine acute myocardial injury from chronic through identifying the presence and extent of myocardial oedema/inflammation.[6] Areas of scarring is enhanced by LGE contrast agents washing from the myocardium with increased extracellular space such as fibrosis.[6] Fibrosis scars extending from the subendocardium to the epicardium are usually ischaemic.[6] Conversely, a typical non-ischaemic scar is present in the epicardium, in the mid-wall, or at the insertion points of the right ventricle.[6]

Further, CMR is able to identify the cause in approximately 90% of MINOCA patients[26] and is used as the benchmark non-invasive method to diagnose non-coronary conditions such as myocarditis and other cardiomyopathies.[30] In a study by Dastidar et al.,[31] CMR provided a definitive diagnosis in 70% of MINOCA patients, ultimately providing a new diagnosis in 54% of patients and a change in management in 41%. Thus, the ESC's task force and various experts recommends the utilisation of CMR for evaluating underlying pathogenesis of MINOCA patients.[25, 26, 30]

1.7 Management and Prognosis of MINOCA

Whilst treatment strategies are well defined for AMI patients, there are currently no randomised clinical trials investigating different treatment strategies for MINOCA patients. Observational data from the SWEDEHEART (the Swedish Web-system for Enhancement and Development of Evidence-based care in Heart disease Evaluated According to Recommended Therapy) Registry revealed a 23%, 18%, 14% and 10% reduction in major adverse cardiovascular events in MINOCA patients with statin, angiotensin-converting enzyme inhibitor/angiotensin-receptor blocker, beta blockers and dual antiplatelet therapy, accordingly.[32] The ESC suggests empiric treatment with aspirin and statins.[26] Additionally, it is proposed that calcium channel blockers are used for vasospasm if the underlying mechanisms include thromboembolism, coronary spasm and coronary plaque disruption.[26]

The prognosis of patients with MINOCA is guarded and depends on the underlying cause, but overall is not a benign condition that should be underscored.[9] In comparison to MICAD patients, those with MINOCA have a better prognosis, however long-term cardiovascular events is still important to recognise as MINOCA patients are younger and have fewer comorbidities.[25, 33]A systematic review by Pasupathy et al.[25] revealed an in-hospital and 12-month all-cause mortality of 1.1% and 3.5% accordingly. These values are similar to the ANZAC (All New Zealand Acute Coronary Syndrome) study[34] reporting a 12-month mortality of 3.2%, and the SWEDEHEART study[32] reporting a 4 year mortality of 13%. The prominent contributor of mortality is non-CVD death.[34] In addition to mortality, hospitalisation rates and symptom burden should be also be considered in MINOCA patients. Grodzinsky et al.[9] revealed that 25% of patients with MINOCA had ongoing post-infarct angina at 12 months, similar to MICAD patients. In a multicenter, observational cohort study of older patients with AMI (≥65 years), 38% of MINOCA patients were re-hospitalised for AMI (1%), heart failure (6%), stroke (2%) and other cardiac conditions.[35] In comparison to MICAD patients, those with MINOCA are less likely to be satisfied with their ongoing treatment and more likely to have a poorer quality of life.[36]

1.8 Significance of research

Establishing MINOCA as a diagnostic entity has initiated a journey in improving the quality of care and understanding of this disorder.[24] Despite investigations such as ECG, echocardiography and coronary angiography, there remains a challenge of establishing a diagnosis on clinical grounds.[30] This difficulty has led to MINOCA patients being often overlooked in contemporary clinical practice. Further, the wide scope of underlying causes warrants more research to understand how MINOCA patients can be characterized (both on prognosis and clinical features) according to their diagnostic workup findings. An important next step includes a multicenter randomised controlled trial investigating secondary prevention therapies on MINOCA patients.[37] It is important to note that the use of CMR has a significant role in providing a definite diagnosis while also excluding other

aetiologies in MINOCA patients.[26] Therefore, this research is important to emphasise the significance of CMR in MINOCA patients whilst also being the first study to evaluate characteristics on the prognosis of MINOCA patients who had CMR in South Australia.

1.9 Aims and Hypothesis

This study aims to characterise patients presenting with MINOCA according to their CMR findings and describe the prevalence, patient characteristics and 12-month clinical outcomes (mortality and re-hospitalisations) of those with (i) evidence of infarction (i.e. myocardial cell death), (ii) evidence of non-ischaemic aetiology (i.e. myocarditis), and (iii) normal CMR findings. Accordingly, the null hypothesis to be tested is patient characteristics and clinical outcomes will not vary according to the CMR findings of MINOCA patients.

2.0 METHODS & MATERIALS

All protocols for this study were subject to prior approval by the Central Adelaide Local Health Network (CALHN) Human Research Ethics Committee (HREC) under the CADOSA (Coronary Angiogram Database of South Australia) Registry, HREC Approval Number: HREC/15/TQEH/252.

2.1 Study Design

2.1.1 Data collection

CADOSA Registry: The CADOSA registry was established in 2012 and is a state-wide database of all consecutive patients undergoing coronary angiography procedures in South Australian public hospitals (The Queen Elizabeth Hospital, Royal Adelaide Hospital, Lyell McEwin Hospital, Flinders Medical Centre & Calvary Hospital). A detailed case report form, compatible with the American College of Cardiology CathPCI Registry, is completed for all patients enrolled in the Registry. Data is captured via an opt-out consent approach. CADOSA data was obtained for patients undergoing coronary angiography between 2012-2017 for AMI and included data on patient demographics, clinical characteristics, angiography findings, medications and in-hospital events. This data was provided following authorisation by the CADOSA Data Custodian for the purpose of this analysis.

From the overall CADOSA AMI data, consecutive patients with AMI and non-obstructive CAD during 2012-2017 were further reviewed to capture additional data not contained in the CADOSA Registry. This included an evaluation of the clinical context of cardiac troponin T (cTnT) elevation, including obtaining all cTnT results during the admission, obtain MRI findings, echo findings and other additional investigations, such as pulmonary embolism (PE) testing, conducted during admission.

2.1.2 Clinical Criteria – AMI

The CADOSA Registry identifies AMI patients according to the Fourth Universal Definition of AMI devised by The European Society of Cardiology/American College of Cardiology Joint Task Force:[6] Positive cardiac biomarker (detection of a rise/fall of cardiac troponin value above the 99th percentile upper reference limit), ischaemic symptoms (chest pain lasting >10 mins) and ischaemic electrocardiography (ECG) changes.

2.1.3 MINOCA Study Group

The MINOCA study group included MINOCA patients identified in the CADOSA Registry undergoing CMR either during their hospitalisation, or at the next available booking.

Inclusion criteria	
(i)	Confirmed clinical diagnosis of AMI and undergoing coronary angiography
(ii)	Non-obstructed coronary arteries (stenosis severity <50%) on angiography
(iii)	Troponin elevation above 90ng/ml
(iv)	CMR undertaken
Exclusion criteria	
(i)	Patients undergoing coronary angiography with MICAD
(ii)	Patients undergoing coronary angiography following cardiac arrest
(iii)	Patients undergoing coronary angiography with insufficient data recorded in the registry
(iv)	MINOCA patients not undergoing CMR or with troponin elevation below 90ng/ml
(v)	MINOCA patients with insufficient CMR data

2.2 Collection of Prognosis Data

Outcomes for patients were obtained following review of hospital administrative and electronical medical records. The outcomes collected included all-cause mortality and re-hospitalisation. In and out of hospital deaths occurring 12-months post discharge were identified. Re-hospitalisation data was collected for 12 months post discharge and defined as cardiac and non-cardiac readmission to any South Australian public hospital, based on the primary diagnosis recorded for the admission.

Patients were classified as having experienced:

All-cause mortality: Identified as a death occurring in hospital or out of hospital regardless of the cause of death.

Cardiac readmission: Any cardiac readmission over 12 months. If a patient experienced both a cardiac and non-cardiac readmission, they were only classified as a cardiac readmission.

Non-cardiac readmission: Any non-cardiac readmission over 12 months but no cardiac readmissions.

Additionally, a composite **all-cause readmission outcome** was collected reflecting patients with any cardiac or any non-cardiac readmission over 12 months.

2.3 CMR classification/Diagnosis

2.3.1 Pre-CMR Classification/Diagnosis

Pre-CMR diagnosis was determined by medical record documentation of the clinician's suspected diagnosis which was based on a composite of clinical, biomarkers, ECG, echocardiographic and angiographic information. This information was used to then classify MINOCA patients into the following diagnostic groups: myocarditis, MI, TTC, other cardiomyopathy and uncertain.

2.3.2 Post-CMR Classification/Diagnosis

All CMRs undertaken in relation to the AMI admission for MINOCA patients were reviewed and patients were classified into one of the following three groups based on the CMR diagnosis in conjunction with the clinical context:

Infarction: CMR confirmed MI was diagnosed by territorial subendocardial and/or transmural LGE.

Non-ischaemic: CMR confirmed cardiomyopathy: myocarditis, TTC or other cardiomyopathy.

Normal: Structurally normal heart, defined as no regional wall motion abnormality, no myocardial oedema, no myocardial LGE in left ventricular.

The CMR diagnosis was corroborated in conjunction with a MINOCA expert.

2.4 Primary outcomes

The primary outcomes for this study were

(1) Prevalence of CMR confirmed infarction (i.e. myocardial cell death), non-ischaemic diagnoses (i.e. myocarditis), and (iii) normal cMRI findings.

(2) Comparison of clinical features and prognostic outcomes (mortality and readmission) of MINOCA patients according to their CMR diagnosis

2.5 Statistical Analysis

Data for continuous variables are presented as mean ± standard deviation. Categorical variables are presented as frequencies and percentages. Clinical data and prognosis data were analysed for the overall study group and then compared between the three post-CMR classification/diagnosis groups. Comparisons were performed using linear or logistic models according to the dependent outcome being either continuous or binary and the CMR diagnosis (infarct, ischaemic or normal) being the categorical predictor variable. A p-value of <0.05 was considered statistically significant. All analyses were performed using SPSS Version 25 for MacOS Mojave.

3.0 RESULTS

A total of 9585 patients with AMI and non-obstructive CAD during 2012-2017 were identified in CADOSA, of which 90% (n=8644) were excluded for having evidence of MICAD (n= 7725), minor troponin rise (n= 422), cardiac arrest (n= 489) and insufficient data (n= 8). The remaining 10% (n= 941) of patients were considered MINOCA but only 23% (n= 218) of these patients had undergone a CMR. A total of 177 MINOCA patients were included into the study as 41 patients had insufficient CMR data. The prevalence of the post-CMR classification/diagnosis was: 9% (n= 16) had an infarct, 70% (n=124) were non-ischaemic and 21% (n= 37) had normal CMR results (Figure 1).

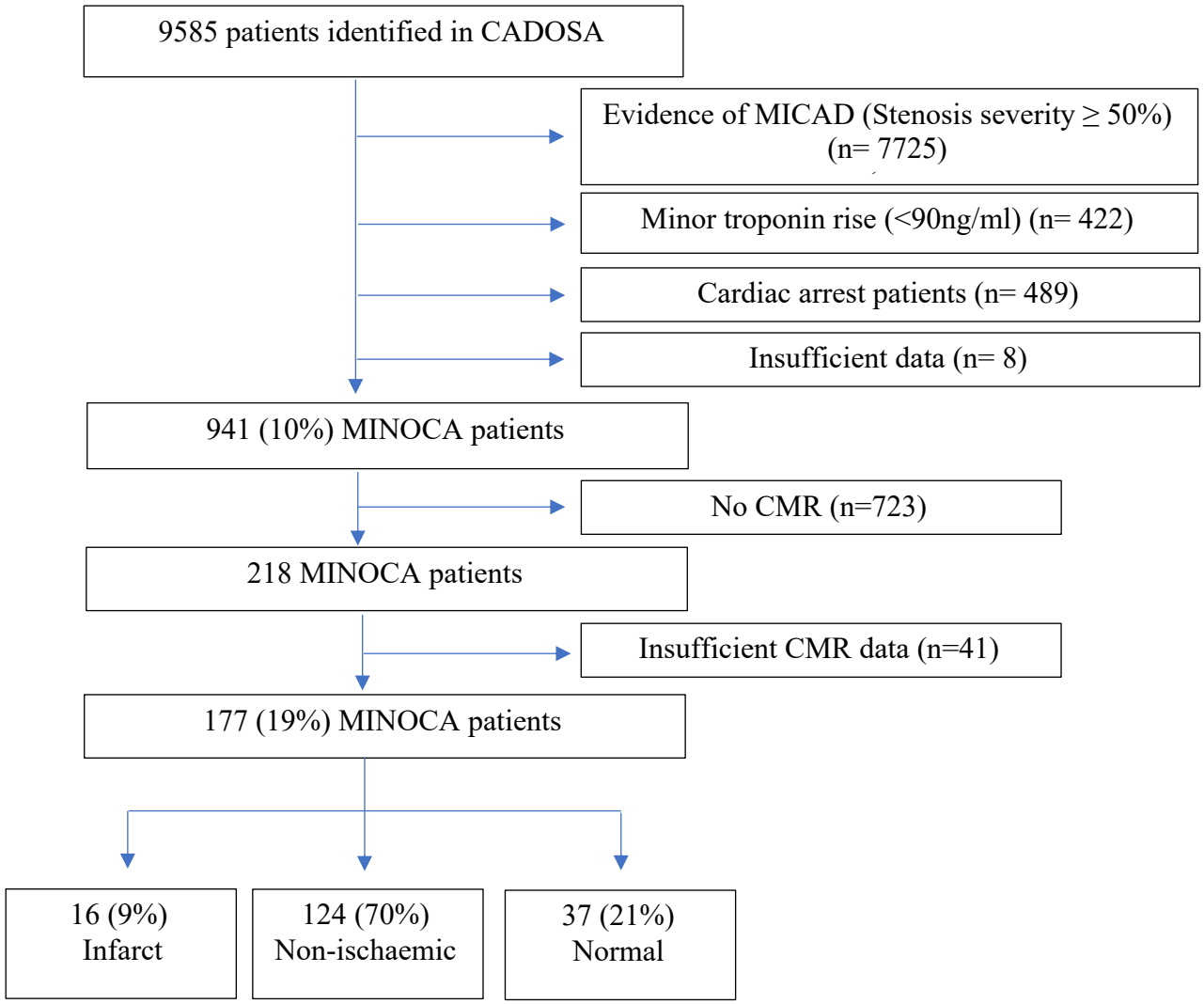

Figure 1. Retrospective analysis profile for MINOCA patients undergoing CMR between 2012-2017.

3.1. Baseline data

3.1.1. Baseline Clinical Characteristics

All data presented is related to the final MINOCA group with CMR findings available (n=177). Baseline clinical characteristics for MINOCA patients undergoing CMR is summarised in table 1. The mean age overall was 58±16 years, where 62% of the cohort were female. Compared to the non-ischaemic group, the infarct group were on average older (66±13 vs. 57±16, $p<0.05$) and compared to the normal group, the infarct patients were more often women (81% vs. 54%, $p<0.05$).

Table 1. Baseline clinical characteristics of MINOCA patients undergoing CMR. AMI: Acute myocardial infarction, CAD: coronary artery disease, COPD: Coronary obstructive pulmonary disease.

Baseline Clinical Characteristics											
	Overall		**Infarct**		**Non-ischaemic**		**Normal**		**P-value**		
	(n= 177)		**(n=16)**		**(n=124)**		**(n=37)**				
Variable	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**Infarct vs. Non-Ischaemic**	**Infarct vs. Normal**	**Non-Ischaemic vs. Normal**
Age, years (mean/SD)	58 (16)		66 (13)		57 (16)		57 (16)		0.037*	0.059	0.984
Gender (female)	109	62%	13	81%	76	61%	20	54%	0.131	0.07*	0.432
Weight, Kg (mean/SD)	78 (18)		78 (13)		77 (19)		85 (18)		0.892	0.241	0.061
Height, cm (mean/SD)	167 (11)		158 (10)		169 (11)		165 (8)		0.007*	0.05*	0.156
Ethnicity											
Indigenous/Torres Strait Islander	3	2%	0	0%	2	2%	1	3%	0.999	0.999	0.670
Cardiac risk factors											
Smoker	42	25%	2	13%	33	28%	7	19%	0.239	0.604	0.310
Hypertension	81	48%	11	69%	50	43%	20	54%	0.058	0.322	0.230
Dyslipidaemia	71	41%	10	62%	50	42%	11	30%	0.129	0.029*	0.184
Diabetes Mellitus	21	12%	3	19%	10	8%	8	22%	0.183	0.813	0.028*
Previous Cardiac History											
Prior AMI	9	5%	2	13%	6	5%	1	3%	0.244	0.195	0.566
Prior heart failure	7	4%	1	6%	4	3%	2	5%	0.562	0.903	0.563
Family CAD	60	37%	3	21%	46	40%	11	32%	0.181	0.452	0.402
Prior Angiogram	11	13%	2	29%	7	12%	2	11%	0.241	0.275	0.874
Peripheral Artery Disease	3	2%	0	0%	3	3%	0	0%	0.999	-	0.998
Comorbidities											
Depression	43	25%	4	27%	32	26%	7	21%	0.971	0.639	0.503
Sleep Apnoea	2	3%	0	0%	1	2%	1	6%	0.999	0.999	0.415
COPD	15	9%	1	7%	10	8%	4	11%	0.824	0.611	0.576
Cerebrovascular Disease	9	5%	0	0%	8	7%	1	3%	0.999	0.999	0.381
Current dialysis	1	1%	0	0%	0	0%	1	3%	-	0.999	0.996
Asthma	30	18%	3	20%	21	17%	6	18%	0.800	0.845	0.968

3.1.2 Discharge medication

Discharge medications pre-CMR for MINOCA patients are demonstrated in table 2. The infarct group received more ticagrelor (25%) in comparison to the non-ischaemic group (4%, $p<0.05$) and normal group (3%, $p<0.05$). The normal group were prescribed more calcium channel blockers compared to the non-ischaemic group (24% vs. 9%, $p<0.05$).

Table 2. Discharge medication pre-CMR for MINOCA patients undergoing CMR. ACE inhibitors: angiotensin-converting-enzyme inhibitors, β- blockers: Beta blockers.

Discharge Medication											
	Overall		**Infarct**		**Non-ischaemic**		**Normal**		**P-value**		
	(n= 177)		**(n=16)**		**(n=124)**		**(n=37)**				
Variable	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**Infarct vs. Non-Ischaemic**	**Infarct vs. Normal**	**Non-Ischaemic vs. Normal**
Aspirin	92	52%	10	63%	61	49%	21	57%	0.321	0.697	0.42
Clopidogrel	13	7%	2	13%	8	7%	3	8%	0.386	0.618	0.727
Ticagrelor	10	6%	4	25%	5	4%	1	3%	0.05*	0.033*	0.71
Statins	87	49%	9	56%	59	48%	19	51%	0.515	0.743	0.687
β- blockers	74	42%	7	44%	56	45%	11	30%	0.915	0.325	0.98
Calcium Channel Blockers	23	13%	3	19%	11	9%	9	24%	0.227	0.657	0.016*
Nitrate	23	13%	4	25%	12	10%	7	19%	0.082	0.617	0.133
Ace inhibitors	98	55%	9	57%	69	56%	20	54%	0.963	0.883	0.864
Angiotensin	29	16%	2	13%	17	14%	10	27%	0.894	0.258	0.062
Ace inhibitor and/or angiotensin receptor blocker	125	71%	11	69%	85	69%	29	78%	0.987	0.457	0.252

3.2 Further diagnostic investigation

Further diagnostic investigation and CMR parameters are outlined in table 3. The normal patients had a higher ejection fraction on CMR (65±12) compared to the infarct group (53±16, P<0.05) and the non-ischaemic group (49±18, P<0.05).

Table 3. Further diagnostic investigation and CMR findings for MINOCA patients undergoing CMR. PE: Pulmonary embolism, Echo= Echocardiogram, Ef: Ejection fraction.

Further diagnostic investigation											
	Overall		**Infarct**		**Non-ischaemic**		**Normal**		**P-value**		
	(n= 177)		**(n=16)**		**(n=124)**		**(n=37)**				
Variable	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**Infarct vs. Non-Ischaemic**	**Infarct vs. Normal**	**Non-Ischaemic vs. Normal**
PE testing											
PE testing	13	7%	2	13%	6	5%	5	14%	0.236	0.920	0.081
Echocardiogram											
Echo testing	92	53%	9	56%	63	51%	20	54%	0.705	0.883	0.762
Ef (mean/SD)	46 (19)		56 (8)		40 (21)		58 (3)		0.08	0.758	0.08
CMR											
Ef (mean/SD)	53 (18)		53 (16)		49 (18)		65 (12)		0.455	0.008*	<0.001*

3.3 12-month Outcomes

3.3.1 All-cause mortality

All-cause mortality within 1 month, 1-12 months and over 12 months are presented in figure 2. There were no in-hospital mortality events amongst all three groups. Within 1 month, mortality was only observed in the non-ischaemic group (1%). Although not statistically significant, within 1-12 months, the infarct group had the highest mortality (6%) followed by the non-ischaemic group (2%). Similar non-statistically significant results were seen across 12 months where the infarct group had the highest mortality (6%), followed by the non-ischaemic group (2%) and no mortality in the normal group.

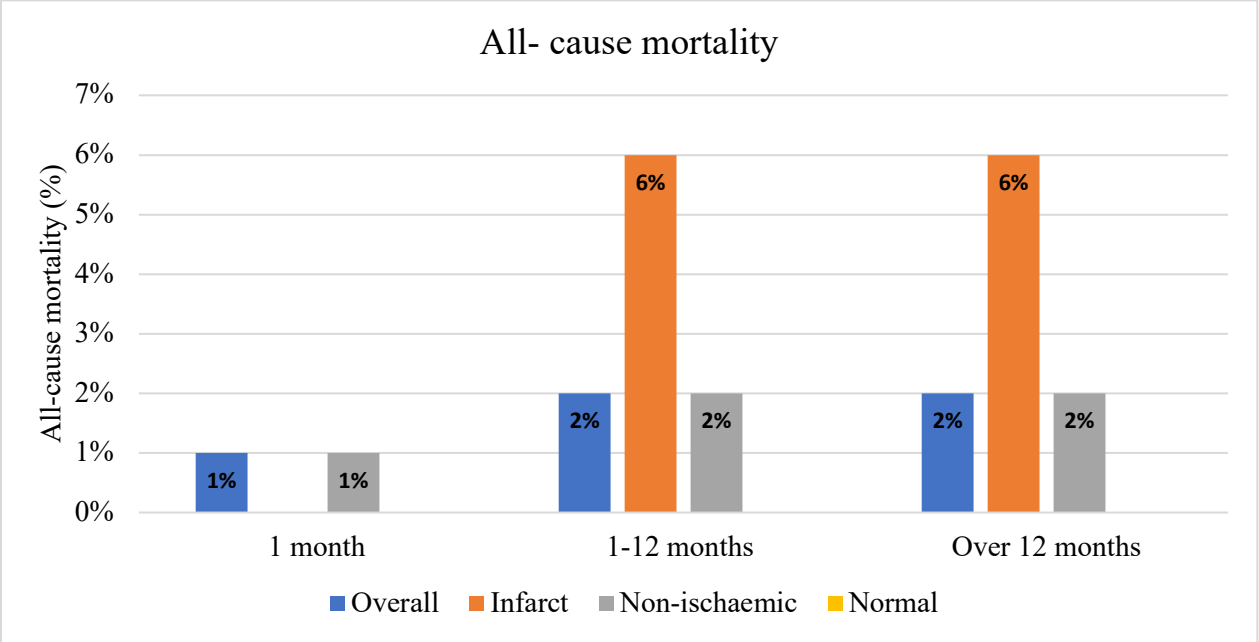

Figure 2. All- cause mortality of MINOCA patients at 1 month, 1-12 months and over 12 months.

3.3.2. Cardiac and non-cardiac readmission within 1 month, 1-6 months and 6-12 months

Cardiac and non-cardiac readmissions for all MINOCA patients are outlined in table 4. At 1 month, the overall cardiac readmission rate was 7% and 8% for non-cardiac readmissions. These rates were similar for the three groups. At 1-6 months, the overall cardiac and non-cardiac readmission rate were both 7%. Although not statistically significant, the infarct patients experienced no cardiac readmissions, but the non-ischaemic and normal patients did (7% and 8% respectively). At 6-12 months, again the overall cardiac and non-cardiac readmission rate were both 7%. At this time point, these readmissions were experienced by the infarct and non-ischaemic patients only (6% each).

Table 4. Cardiac and non-cardiac readmissions of MINOCA patients at 1 month, 1-6 months and 6-12 months.

Readmission											
	Overall		**Infarct**		**Non-ischaemic**		**Normal**		**P- value**		
	(n= 177)		**(n=16)**		**(n=124)**		**(n=37)**				
Variable	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**Infarct vs. Non-Ischaemic**	**Infarct vs. Normal**	**Non-Ischaemic vs. Normal**
Within 1 month											
All-cause	25	14%	2	13%	17	14%	6	16%	0.894	0.729	0.703
Cardiac	12	7%	1	6%	8	7%	3	8%	0.975	0.815	0.727
Non-cardiac	14	8%	1	6%	10	8%	3	8%	0.800	0.815	0.993
Between 1-6 months											
All-cause	21	12%	1	6%	17	14%	3	8%	0.415	0.815	0.370
Cardiac	12	7%	0	0%	9	7%	3	8%	0.999	0.999	0.863
Non-cardiac	13	7%	1	6%	11	9%	1	3%	0.726	0.545	0.238
Between 6-12 months											
All-cause	20	11%	2	13%	16	12%	2	5%	0.964	0.382	0.219
Cardiac	8	7%	1	6%	7	6%	0	0%	0.922	0.998	0.998
Non-cardiac	13	7%	1	6%	10	8%	2	5%	0.800	0.903	0.591

3.3.3. Cardiac and non-cardiac readmissions over 12 months

Figure 3 demonstrates the cardiac and non-cardiac readmission of MINOCA patients over 12 months. Overall, 29% of patients experienced any admission, 16% of patients experienced only cardiac readmission and 18% of patients experienced only non-cardiac admissions. There were no statistical significance differences amongst the readmissions data.

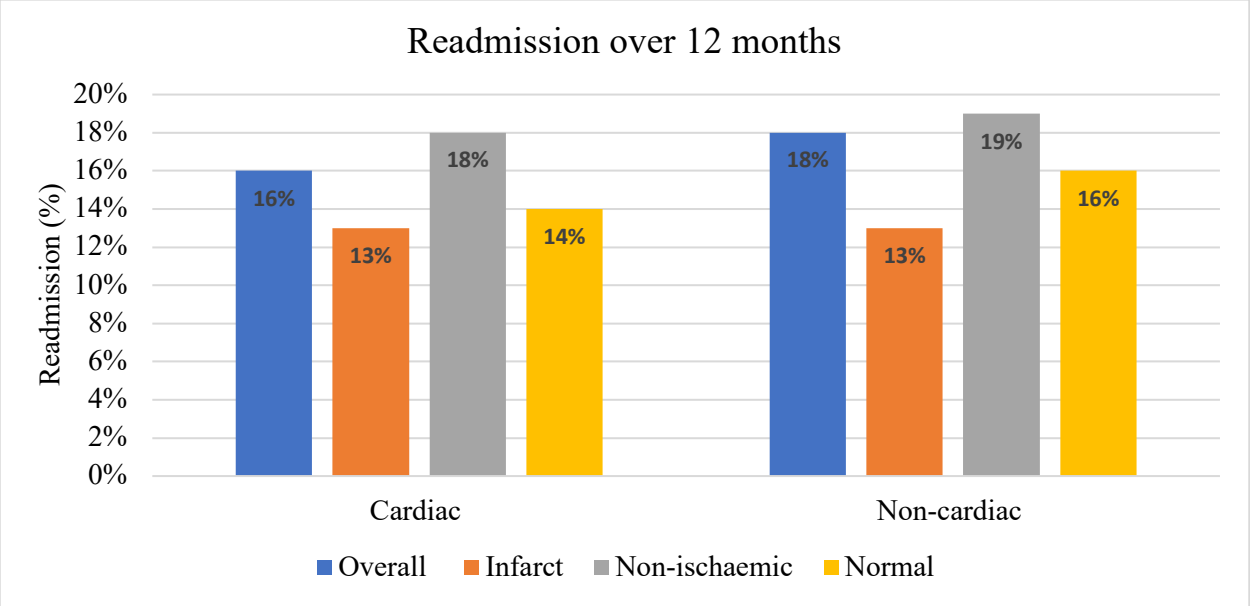

Figure 3. Cardiac and non-cardiac readmission of MINOCA patients over 12 months.

3.3.4 Cardiac readmission causes for MINOCA patients

The cardiac readmission causes over 12 months is shown in figure 4. Angina accounted for half of cardiac readmissions (49%).

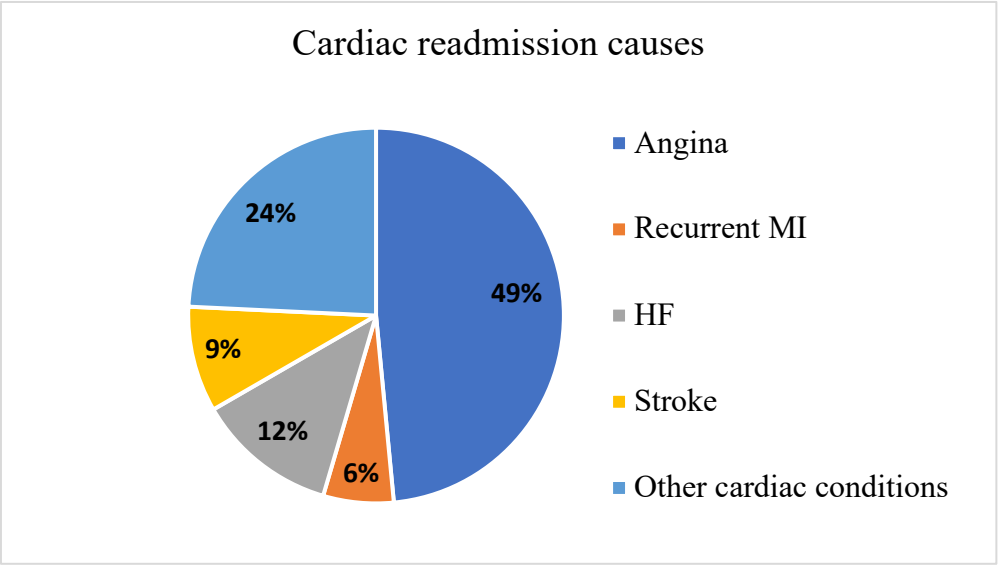

Figure 4. Cardiac readmission causes for MINOCA patients within 12 months. MI: myocardial infarction, HF: heart failure.

3.3.5 Cardiac readmission causes according to CMR diagnosis

The cardiac readmission causes for MINOCA patients according to their CMR diagnosis within 12 months is presented in figure 5. The normal group experienced the most angina (11%), followed by the non-ischaemic group (10%) and no angina admissions for the infarct group. The only group to have recurrent MI was those with a non-ischaemic diagnosis (2%). The infarct group had the highest heart failure (5%) and stroke (6%) readmission compared to other groups. There were no statistical significances amongst the data.

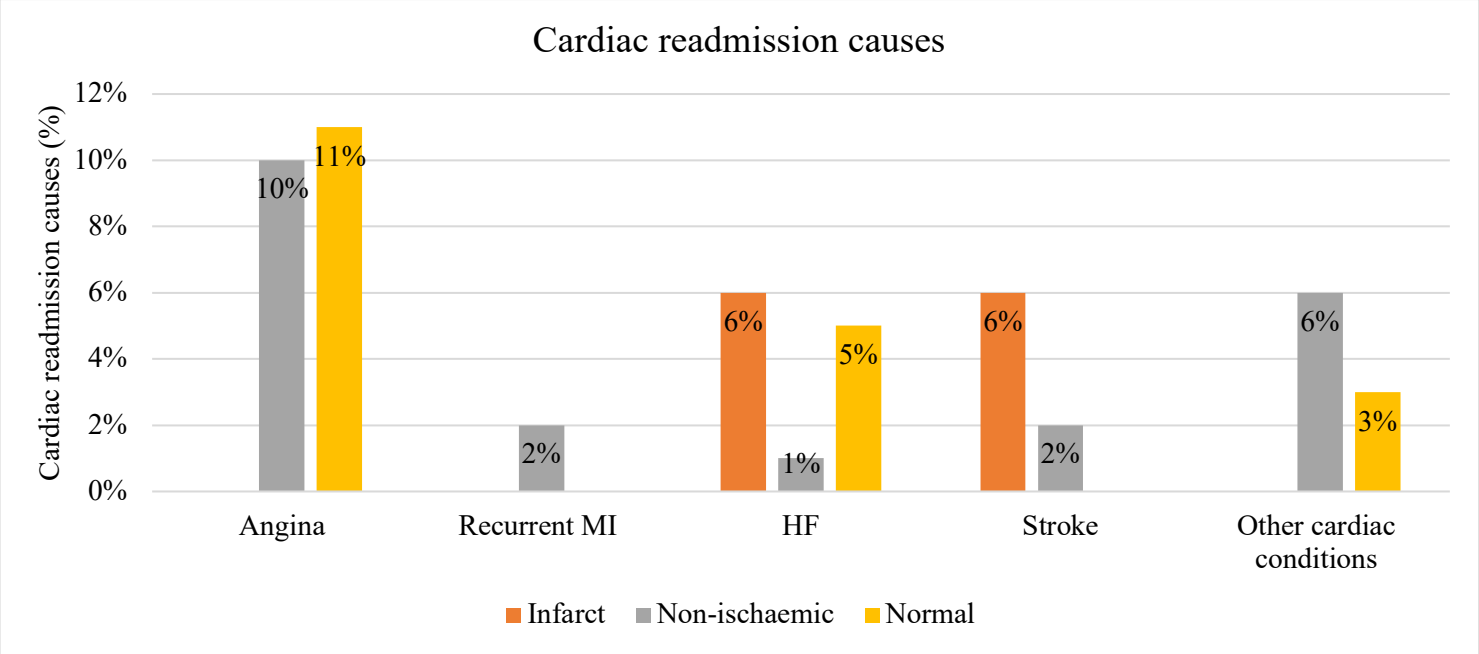

Figure 5. Cardiac readmission causes for MINOCA patients within 12 months, according to CMR diagnosis.

3.4 Comparison of pre-CMR diagnosis to post-CMR diagnosis

Comparison of pre-CMR to post-CMR diagnosis is demonstrated in figure 6. The pre-CMR diagnosis did not change in over half of patients following the CMR (indicated in blue). However, CMR provided a new diagnosis in 43% (n= 76) of patients. TTC was the most consistent diagnosis before and after CMR (n= 54).

Total Sample n=177	**Post- CMR diagnosis**					
Pre- CMR diagnosis		Takotsubo	Myocarditis	MI	Other CM	Normal
	Takotsubo	54	0	1	1	12
	Myocarditis	0	18	0	0	6
	MI	2	2	7	3	1
	Other CM	0	2	0	5	1
	Uncertain	8	27	8	2	17

Figure 6. Pre-CMR diagnosis compared to post-CMR diagnosis

4. DISCUSSION

This study is the first to evaluate the prognosis of MINOCA patients according to their CMR diagnosis. It demonstrates that between 2012-2017, there were 941 MINOCA patients in South Australia and of these only 218 (23%) underwent CMR. Of the 177 patients with CMR data (58 ± 16 years; 62% women) included in the study, CMR provided a specific diagnosis in 79% of patients. The prevalence was 9% (n=16) had an infarct, 70% (n= 124) were non-ischaemic and 21% (n= 37) had normal CMR results.

The raised troponin in MINOCA patients with normal CMR is either indicative of myocardial injury or an alternate diagnosis. The prevalence of normal CMR (21%) is consistent with other studies, including a meta-analysis of 26 CMR studies investigating MINOCA (8-26%).[25] With current techniques, LGE-CMR cannot detect myocardial injury below approximately 1 gram.[38] Thus, the normal CMR appearance may be a result of necrotic myocytes dispersed over a larger area with no connecting island of cell death of sufficient size to be detected by LGE imaging. Further, it is possible that a proportion of patients with troponin elevation may also be a biochemical false positive.

Additionally, studies such as Dastidar et al.[31] have demonstrated the importance of performing early CMR (<2 weeks) in MINOCA patients to maximise diagnostic yield by capturing myocardial damage before healing occurs. This is important in reversible conditions such as myocarditis and TTC.[31] In this study, the median time for CMR to be conducted after presentation was 3 days (interquartile range, 4 days) where 70% of patients had a CMR within 2 weeks, suggesting that perhaps timing may have been a factor in the remaining patients who had late CMR (>2 weeks). Management of normal CMR patients remains unclear as studies have yet to address this subgroup.[26]

Prognostically, the study strengthens the growing evidence that the MINOCA population should not be viewed as a low risk subtype of MI. Overall at the 12-month point, mortality was 2% and the

overall readmission rate was 29% (Figure 2 & 3, respectively). Although not statically significant, the infarct patients had the highest all-cause, 12-month mortality (6%) followed by the non-ischaemic patients (2%) and none for the normal patients (Figure 2). Whilst it is plausible that the death in the infarct group was non-cardiac related, underlying disease progression cannot be excluded, underscoring that MINOCA patients require further attention in follow-up and secondary prevention measures.

As with earlier studies, myocarditis accounts for the most common underlying pathology, contrary this study as 49 (28%) of patients were diagnosed with myocarditis on CMR and 64 (36%) with TTC (Figure 6). This is in contrast to earlier work by Assomull et al.[39] who only reported one cause of TTC, but similar to a more recent study by Pathik et al.[30] (27%). TTC patients often have on-going symptom burden and repeat TTC.[40] As TTC patients accounted for 52% of non-ischaemic patients alone, this may explain why this subgroup had the highest 12-month cardiac readmission (18%, Figure 3). Further, over 12 months, the normal patients still experienced a moderate rate of cardiac readmission (14%) compared to a similar rate of 13% in the infarct group (Figure 3). A potential explanation is that the infarct patients are being diagnosed via CMR as having an 'infarct', and perhaps they were provided with more optimal secondary preventative measures and thus had similar readmission rate to the normal patient group. However, it should also be considered, as aforementioned, that the 'normal' CMR patients may have too little myonecrosis to be detected but still in-fact have suffered an infarct, leading to inadequate secondary preventative measures, and thus a high readmission burden, similar to that of infarct patients. This can be supported by these normal patients experiencing heart failure (5%) and the most angina (11%) (Figure 5).

The data represented in figure 4 and 5 show that angina accounts for half of the cardiac readmission causes by non-ischaemic and normal patients. Therefore, perhaps strategies to reduce symptom burden is warranted for these patients. MINOCA patients should therefore receive close follow-up as

the moderate rate of readmissions, dominated by repeat angina symptoms, reinforces the importance of establishing a correct diagnosis and regular follow-up.

Overall, CMR had a significant clinical impact in 76 (43%) of patients by providing a new diagnosis (Figure 6). This figure was smaller, yet not considerably different to other publications such as Dastidar et al.[30] (54%) and Assomull et al.[39] (65%). This highlights the potential risk of underdiagnosing and therefore undertreating patients without the utility of the CMR findings. For example, if a patient received a clinical diagnosis of AMI but had evidence of myocarditis on CMR, this patient would not have received important treatments for myocarditis such as corticosteroids if managed purely on clinical grounds. Although collecting data on change in management was out of scope of the current study, it provides direction for future studies. A correct diagnosis is imperative for providing outpatient follow-up management, appropriate counselling and future risk stratification.

Reflecting on the use of cardiac medications prescribed at discharge in conjunction with the post CMR diagnosis, only 63% of infarct patients received aspirin therapy, although clinical guidelines[41, 42] recommend all AMI patients should be given this antiplatelet medication (Table 2), Patients with a normal CMR may be considered to require less aggressive cardiac medication, however they received more aspirin, statins and nitrates compared to non-ischaemic patients (57% vs. 49%, 51% vs. 48% and 19% vs. 10%, respectively, Table 2). Additionally, the normal patients received the most ace inhibitor and/or angiotensin receptor blocker, another guideline recommended therapy for AMI patients, (78%) compared to the non-ischaemic and infarct patients (69% each) (Table 2). These inconsistencies can be explained by the medication being prescribed prior to CMR. Hence, the clinicians were treating the pre-CMR diagnosis rather than the CMR diagnosis. Comparison of medications prescribed before and after CMR findings may provide better insights on how MINOCA patients are receiving treatment according to their CMR diagnosis. Future studies evaluating how CMR guided management impacts on prognostic outcomes is also warranted. It is important to also

note that the clinical guideline evidence for the use of cardiac secondary prevention measures has been generated largely from studies in MICAD patients and there is little data on the benefits of these measures specifically in MINOCA patients. This issue is currently being addressed in a randomised controlled trial in Australia and Sweden.[43]

Several limitations merit consideration. Firstly, there may be a selection bias in this study. Patients were recruited based on if they had a CMR undertaken, and thus clinicians believed that further diagnostic investigation needed to be undertaken in these patients. Thus, a study where all MINOCA patients undergo a CMR would improve the generalisability of the findings and applicability in the real world. Secondly, another limitation involves the lack of diversity in patients due to sourcing them from South Australia only. Hence, it is recommended to widen the geographical sources for patients which will also increase sample size. To enhance the understanding of MINOCA patient outcomes, prognosis studies necessitate a larger sample size. A post-hoc power calculation using the cardiac readmission rates in this study for the infarct, ischaemic and normal patient groups (13%, 18% and 14% respectively), estimate that over 800 patients in each group would be required to determine a statistically significant difference in outcomes. This type of study and sample size could be achieved through national or international collaborations.

In addition to improving diagnostic certainty, the additional value of CMR in MINOCA patients could be further exemplified by documenting the impact both in terms of clinical and health service utilisation. Although identifying patients who had a change in diagnosis after CMR was important, it does not imply that a change in management occurred. Hence, investigating changes in length of hospital stay, changes in discharge medications, association with clinical outcomes, and the introduction and/or avoidance of additional invasive procedures can better capture the effects CMR can have on MINOCA patients beyond providing a diagnosis.

5. CONCLUSION

It is important to identify the underlying cause of MINOCA for each patient to ultimately guide ongoing management and provide patient assurance and guidance on their condition. The study strengthens the evidence that CMR is a clinically relevant non-invasive imaging modality for the assessment of patients presenting with MINOCA by providing a specific diagnosis in 79% of patients. Additionally, CMR had a significant clinical impact in 76 (43%) of patients by providing a new diagnosis. Accordingly, there is scope for improved understanding of patients with a normal diagnosis on CMR and how this diagnostic tool can change management in MINOCA patients, and ultimately optimise their clinical outcomes.

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APPENDIX A

The CADOSA Data Collection Form

CADOSA

Coronary Angiogram Database of South Australia
Diagnostic Catheterisation and Percutaneous Coronary Intervention Registry

FACILITY[1010]

○ CW ○ FMC ○ LMH ○ RAH ○ TQEH

Patient in Follow-up Study? [1020] ○ No ○ Yes

PART A: DEMOGRAPHICS

Surname [2000]:

First Name [2010]:

Middle Name [2020]:

Medicare No [2030]: |__||__||__||__||__||__||__||__||__||__||__| **Patient UR** [2040]: |__||__||__||__||__||__||__||__||__||__||__|

Post Code [3005]: |__||__||__||__| **Postcode N/A** [3006]: ☐ **Date of Birth** [2050]: |__||__|dd |__||__|mm |__||__||__||__|yyyy **Gender** [2060]: ○ M ○ F

Ethnicity: ☐ Caucasian [2070] ☐ Indigenous/Torres Strait Islander [2071] ☐ Asian [2072] ☐ Hispanic [2073]
☐ African [2074] ☐ Sub-Continent [2075] ☐ Other [2076,2077] (specify) _____

PART B: EPISODE OF CARE and CHEST PAIN EVALUATION

Arrival to Cath Facility Date [3000]: |__||__|dd |__||__|mm 20|__||__|yyyy **Time** [3001]: |__||__|hh : |__||__|mm 24 hr

Referral Source [3010]: ○ Emergency Department ○ Admissions Office ○ Current In-patient ○ Transfer in From Other Acute Care Facility

Payer for Episode of Care [3020]: ○ Private Health Insurance ○ Medicare Only ○ Veteran Gold Card ○ Other

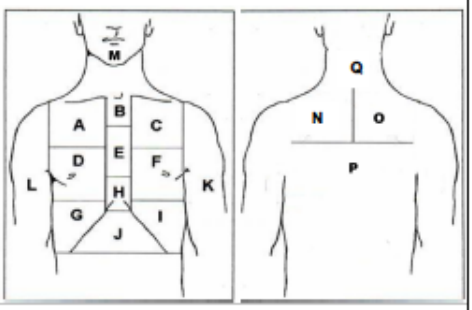
Transport to Cath Facility [3040]: ○ Self ○ SAAS ○ Air Ambulance ○ MedSTAR ○ Inter-hospital transfer - Air ○ Inter-hospital transfer – road

THE FOLLOWING QUESTIONS RELATE TO THE CHEST PAIN SYMPTOMS PROMPTING THIS DIAGNOSTIC CATHERTERISATION

Chest Pain Prompting this Diagnostic Catheterisation [3041]: ○ No ○ Yes ○ Unknown → If yes, complete below

Location of Chest Pain: (check all that apply)

☐ A[3042] ☐ B[3043] ☐ C[3044]
☐ D[3045] ☐ E[3046] ☐ F[3047]
☐ G[3048] ☐ H[3049] ☐ I[3050]
☐ J[3051] ☐ K[3052] ☐ L[3053]
☐ M[3054] ☐ N[3055] ☐ O[3056]
☐ P[3057] ☐ Q[3058] ☐ Other[3059]
☐ Unknown[3060]



Quality of Chest Pain: ☐ Burning [3061] ☐ Squeezing [3062] ☐ Tightness [3063] ☐ Sharp [3064] ☐ Heavy [3065] ☐ Other [3066, 3067] _____ ☐ Unknown [3068]

Precipitating Factors: ☐ Exertion [3069] ☐ Meals [3070] ☐ Emotional Stress [3071] ☐ Cold Weather [3072] ☐ Nocturnal [3073] ☐ Lying Down [3074] ☐ Pleuritic [3075] ☐ Only at Rest [3076] ☐ Other [3077, 3078] _____ ☐ Unknown [3079]

Relieving Factors: ☐ Rest [3080] ☐ Nitrates (<5 mins) [3081] ☐ Nitrates (> 5 mins) [3082] ☐ Antacids [3083] ☐ Other [3084, 3085] _____ ☐ Unknown [3086]

Associated Symptoms: ☐ Tachypnea [3087] ☐ Rapid Palpitations [3088] ☐ Pre-syncope/syncope [3089] ☐ Post-pain fatigue [3090] ☐ Nausea/vomiting [3091] ☐ Sweating [3092] ☐ Chest Wall Tenderness [3093] ☐ Other [3094, 3095] _____ ☐ None [3096] ☐ Dyspnea [3097] ☐ Unknown [3098]

Typical Duration [3099] ○ ≤ 15 seconds ○ > 15 seconds ≤ 15 minutes ○ > 15 minutes ≤ 30 minutes ○ > 30 minutes ≤ 60 minutes ○ > 60 minutes ≤ 2 hours ○ > 2 hours ≤ 6 hours ○ > 6 hours ≤ 12 hours ○ > 12 hours ○ Unknown

APPENDIX A (CONTINUED)

CADOSA — **Coronary Angiogram Database of South Australia**
Diagnostic Catheterisation and Percutaneous Coronary Intervention Registry

PART C: HISTORY and RISK FACTORS (ON ARRIVAL TO CATH FACILITY)

Smoking History 4000: ○ Current ○ Recent (< one year) ○ Former ○ No Smoking History ○ Unknown
Pack Years 4001 (Note 1): |__|__|

Hypertension 4005:	○ No ○ Yes ○ Unk
Dyslipidemia 4010:	○ No ○ Yes ○ Unk
Family Hx of Premature CAD 4015:	○ No ○ Yes ○ Unk
Prior MI 4020:	○ No ○ Yes ○ Unk
Prior Heart Failure 4025:	○ No ○ Yes ○ Unk
Prior Valve Surgery/Procedure 4030:	○ No ○ Yes ○ Unk
Prior Angiogram 4031:	○ No ○ Yes ○ Unk
→ If yes, **Most Recent Angiogram Date** 4032:	
|__|__|dd |__|__|mm |__|__|__|__|yyyy	○ Unk
Prior PCI 4035:	○ No ○ Yes ○ Unk
→ If yes, **Most Recent PCI Date** 4040:	
|__|__|dd |__|__|mm |__|__|__|__|yyyy	○ Unk
Prior CABG 4045:	○ No ○ Yes ○ Unk
→ If yes, **Most Recent CABG Date** 4050:	
|__|__|dd |__|__|mm |__|__|__|__|yyyy	○ Unk

Height 4055: |__|__|__| cm ○ Unk
Weight 4060: |__|__|__| kg cm ○ Unk

Currently on dialysis 4065:	○ No ○ Yes ○ Unk
Cerebrovascular Disease 4070:	○ No ○ Yes ○ Unk
Peripheral Arterial Disease 4075:	○ No ○ Yes ○ Unk
Diabetes Mellitus 4085:	○ No ○ Yes ○ Unk → If yes,
Diabetes Diagnosed this Admission 4086:	○ No ○ Yes ○ Unk → If yes,
Diabetes Therapy 4090:	○ None ○ Diet ○ Oral ○ Insulin ○ Other ○ Unk
AF/Flutter 4091:	○ No ○ Yes ○ Unk → If yes,
AF/Flutter Diagnosed this Admission 4092:	○ No ○ Yes ○ Unk
Other Diagnosis:	
Depression 4094:	○ No ○ Yes ○ Unk
Chronic Lung Disease 4095	○ No ○ Yes ○ Unk
Asthma 4096	○ No ○ Yes ○ Unk
Sleep Apnea 4097	○ No ○ Yes ○ Unk
Cancer 4098	○ No ○ Yes ○ Unk

PRE-ADMISSION MEDICATIONS: (INDICATE ALL MEDICATIONS ON ARRIVAL TO CATH FACILITY) (Additional Medication Page Attached ☐)

Cardiovascular Medications	No	Current	New	Unk	Generic Name 4111;	Dose 4112, 4113;	Freq. 4114;
Anti-platelet agents 4100:	○	○	○	○			
Second Anti-platelet agent 4101:	○	○	○	○			
Injectable Anti-coagulants 4102:	○	○	○	○			
Oral Anti-coagulants 4103:	○	○	○	○			
Statin 4104:	○	○	○	○			
Non-Statin Lipid Lowering Agent 4105:	○	○	○	○			
ACE Inhibitor 4106:	○	○	○	○			
Angiotensin Receptor Blocker 4107:	○	○	○	○			
Calcium Channel Blocker 4108:	○	○	○	○			
Beta Blocker 4109:	○	○	○	○			
Long-Acting Nitrate/Anti Angina Agent 4110:	○	○	○	○			

Other Medications 4130: ○ No ○ Yes ○ Unknown → If yes, complete below

Type 4131;	Generic Name 4132;	Dose 4133, 4134;	Freq. 4135;	Therapeutic Class 4136;
○ Cardiovascular ○ Non-Cardiovascular				
○ Cardiovascular ○ Non-Cardiovascular				
○ Cardiovascular ○ Non-Cardiovascular				
○ Cardiovascular ○ Non-Cardiovascular				
○ Cardiovascular ○ Non-Cardiovascular				
○ Cardiovascular ○ Non-Cardiovascular				
○ Cardiovascular ○ Non-Cardiovascular				
○ Cardiovascular ○ Non-Cardiovascular				

Note 1: Pack Years 4001 = (number cigarettes smoked per day X number of years smoked)/20
Example: Patient has smoked 15 cigarettes a day for 40 years, Pack Years = (15 x 40)/20 = 30
If needed, record here number of cigarettes per day _____ and number of years smoked _____

CADOSA — **Coronary Angiogram Database of South Australia**
Diagnostic Catheterisation and Percutaneous Coronary Intervention Registry

PART D: CATH LAB VISIT (Complete for each cath lab visit)

CLINICAL EVAUALATION LEADING TO PROCEDURE (to completed by Physician)

Procedure Indication 5000: ○ No symptoms, no angina ○ Symptoms unlikely to be ischaemic ○ Stable Angina ○ Unstable Angina ○ Non-STEMI (NSTEMI) ○ STEMI

Other indications:
Cardiomyopathy or LVSD 5050: ○ No ○ Yes
Pre-Op Evaluation before non-cardiac surgery 5055: ○ No ○ Yes
☐ Other 5056, 5057 → If yes, Indicate: _____

Cardiac arrest 5064: ○ No ○ Yes ○ Unk → If yes,	**Cardiac arrest w/in 24hrs** 5065: ○ No ○ Yes ○ Unk
Cardiogenic Shock w/in 24 hours 5060: ○ No ○ Yes ○ Unk	**Out of hospital cardiac arrest** 5066: ○ No ○ Yes ○ Unk
Angina Classification w/in 2 weeks 5020: ○ No Symptoms ○ CCSC I ○ CCSC II ○ CCSC III ○ CCSC IV ○ Unk	
Heart Failure w/in 2 weeks 5040: ○ No ○ Yes ○ Unk	
→ If yes, **NYHA Class w/in 2 weeks** 5045: ○ NYHA I ○ NYHA II ○ NYHA III ○ NYHA IV ○ Unk	

GRACE Risk Score At Admission: (For ACS only, Procedure Indication = Unstable Angina, NSTEMI or STEMI)

Age 5070: |__|__|__| years **Heart Rate** 5071: |__|__|__| bpm **Systolic BP** 5072: |__|__|__| mmHg
Cardiac Arrest 5075 ○ No ○ Yes ○ Unk **ST-segment deviation** 5076 ○ No ○ Yes ○ Unk
Creatinine Pre Procedure 5077: |__|__|__| umol/L **Elevated Cardiac Markers** 5078 ○ No ○ Yes ○ Unk
Killip Class 5080: ○ I (no CHF) ○ II (rales and/or JVD) ○ III (pulmonary edema) ○ IV (cardiogenic shock) ○ Unk

Stress or Imaging Studies Performed 5100 (w/in last 6 months): ○ No ○ Yes ○ Unknown → If yes, specify test performed:

Test Performed	No	Yes	Unk		Result	Risk/Extent of Ischaemia
Standard Exercise Stress Test 5200,5201, 5202 (w/o imaging):	○	○	○	→ If yes,	○ Negative ○ Indeterminate ○ Positive ○ Unavailable	○ Low ○ High ○ Intermediate ○ Unavailable
Stress Echocardiogram 5210,5211,5212;	○	○	○	→ If yes,	○ Negative ○ Indeterminate ○ Positive ○ Unavailable	○ Low ○ High ○ Intermediate ○ Unavailable
Stress Testing w/SPECT MPI 5220,5221,5222;	○	○	○	→ If yes,	○ Negative ○ Indeterminate ○ Positive ○ Unavailable	○ Low ○ High ○ Intermediate ○ Unavailable
Stress Testing w/CMR 5230,5231,5232;	○	○	○	→ If yes,	○ Negative ○ Indeterminate ○ Positive ○ Unavailable	○ Low ○ High ○ Intermediate ○ Unavailable
Cardiac CTA 5240,5241;	○	○	○	→ If yes,	○ No disease ○ Indeterminate ○ 1 VD ○ Unavailable	○ 2 VD ○ 3 VD

PROCEDURE INFORMATION

Procedure Date 5300: |__|__|dd |__|__|mm |__|__|__|__|yyyy **Procedure Time** 5301: |__|__|hh |__|__|mm 24 hr
Diagnostic Cath 5310: ○ No ○ Yes **PCI** 5305: ○ No ○ Yes **Able to image coronary arteries** 5311 ○ No ○ Yes
Fluoro Time/Dose 5321/5322; **Time:** |__|__|.|__| mins **OR Dose:** |__|__|__|__|.|__| cGycm2 **Contrast Vol** 5325 |__|__|__| ml
Other Procedure (in conj with Dx Cath/PCI) 5315 ○ No ○ Yes ○ Unk → If yes,

Doppler 5316:	○ No ○ Yes ○ Unk	**FFR** 5318: ○ No ○ Yes ○ Unk	→ If FFR Yes,		
Pressure Wire 5317:	○ No ○ Yes ○ Unk		1	2	3
IVUS 5321:	○ No ○ Yes ○ Unk	→ **FFR Ratio** 5319:	|__|.|__|__|	|__|.|__|__|	|__|.|__|__|
OCT 5322:	○ No ○ Yes ○ Unk	→ **Segment Number** 7105:	_____	_____	_____
Spasm Provocation 5323:	○ No ○ Yes ○ Unk				

MECHANICAL VENTRICULAR SUPPORT

IABP 5330: ○ No ○ Yes ○ Unknown
→ If yes, **Timing** 5335: ○ In place at start of procedure ○ Inserted during procedure and prior to PCI ○ Inserted after PCI has began ○ Unk
Other mechanical ventricular support 5340: ○ No ○ Yes ○ Unknown
→ If yes, **Timing** 5345: ○ In place at start of procedure ○ Inserted during procedure and prior to PCI ○ Inserted after PCI has began ○ Unk

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Diagnostic Catheterisation and Percutaneous Coronary Intervention Registry

ARTERIAL ACCESS:

Arterial Access Site	Operator Name 5356;	Closure Method 5358;
FEMORAL		
Right 5350: ○ Successful ○ Unsuccessful ○ Not Attempted		○ Manual Press ○ Device → Device Name 5359 ○ Other ○ N/A ○ Unk
Left 5351: ○ Successful ○ Unsuccessful ○ Not Attempted		○ Manual Press ○ Device → Device Name 5359 ○ Other ○ N/A ○ Unk
BRACHIAL		
Right 5352: ○ Successful ○ Unsuccessful ○ Not Attempted		○ Manual Press ○ Device → Device Name 5359 ○ Other ○ N/A ○ Unk
Left 5353: ○ Successful ○ Unsuccessful ○ Not Attempted		○ Manual Press ○ Device → Device Name 5359 ○ Other ○ N/A ○ Unk
RADIAL		
Right 5354: ○ Successful ○ Unsuccessful ○ Not Attempted		○ Manual Press ○ Device → Device Name 5359 ○ Other ○ N/A ○ Unk
Left 5355: ○ Successful ○ Unsuccessful ○ Not Attempted		○ Manual Press ○ Device → Device Name 5359 ○ Other ○ N/A ○ Unk

COMPLETE if NSTEMI/STEMI Only N/A 5500

If NSTEMI/STEMI, Pain Onset	**Date** 5400: |__|__|dd |__|__|mm 20|__|__|yyyy **Time** 5401: |__|__|hh : |__|__|mm 24 hr ○ N/A
If NSTEMI, Hospital Arrival	**Date** 5402: |__|__|dd |__|__|mm 20|__|__|yyyy **Time** 5403: |__|__|hh : |__|__|mm 24 hr ○ N/A
If STEMI, Reperfusion **Strategy** 5404:	○ Thrombolysis ○ PCI → Primary PCI 5405 ○ Yes ○ No ○ Thrombolysis and PCI ○ None
If STEMI, First **Medical Contact** 5406:	○ Non-Cath Facility ○ SAAS ○ Cath Facility

If STEMI First Medical Contact is Non-Cath Facility

Arrival to Non-Cath Facility	**Date** 5410: |__|__|dd |__|__|mm 20|__|__|yyyy **Time** 5411: |__|__|hh : |__|__|mm 24 hr ○ N/A
First ECG at Non-Cath Facility	**Date** 5412: |__|__|dd |__|__|mm 20|__|__|yyyy **Time** 5413: |__|__|hh : |__|__|mm 24 hr ○ N/A
Diagnostic ECG at Non-Cath Facility	**Date** 5414: |__|__|dd |__|__|mm 20|__|__|yyyy **Time** 5415: |__|__|hh : |__|__|mm 24 hr ○ N/A
Thrombolytic Therapy at Non-Cath Facility 5416:	○ No ○ Yes
→ If yes	**Date** 5417: |__|__|dd |__|__|mm 20|__|__|yyyy **Time** 5418: |__|__|hh : |__|__|mm 24 hr ○ N/A

If STEMI First Medical Contact is SAAS →

SAAS Arrival	**Date** 5420: |__|__|dd |__|__|mm 20|__|__|yyyy **Time** 5421: |__|__|hh : |__|__|mm 24 hr ○ N/A
First ECG (SAAS)	**Date** 5422: |__|__|dd |__|__|mm 20|__|__|yyyy **Time** 5423: |__|__|hh : |__|__|mm 24 hr ○ N/A
Diagnostic ECG (SAAS)	**Date** 5424: |__|__|dd |__|__|mm 20|__|__|yyyy **Time** 5425: |__|__|hh : |__|__|mm 24 hr ○ N/A

If STEMI First Medical Contact is Cath Facility →

Cath Facility Arrival	**Date** 5430: |__|__|dd |__|__|mm 20|__|__|yyyy **Time** 5431: |__|__|hh : |__|__|mm 24 hr ○ N/A
First ECG at Cath Facility	**Date** 5432: |__|__|dd |__|__|mm 20|__|__|yyyy **Time** 5433: |__|__|hh : |__|__|mm 24 hr ○ N/A
Diagnostic ECG at Cath Facility	**Date** 5434: |__|__|dd |__|__|mm 20|__|__|yyyy **Time** 5435: |__|__|hh : |__|__|mm 24 hr ○ N/A

If STEMI → (COMPLETE FOR ALL PRIMARY PCIs)

Procedure Team On Site 5440:	○ No ○ Yes
Cath Facility Arrival	**Date** 5441: |__|__|dd |__|__|mm 20|__|__|yyyy **Time** 5442: |__|__|hh : |__|__|mm 24 hr ○ N/A
Diagnostic ECG	**Date** 5443: |__|__|dd |__|__|mm 20|__|__|yyyy **Time** 5444: |__|__|hh : |__|__|mm 24 hr ○ N/A
Code Activated	**Date** 5445: |__|__|dd |__|__|mm 20|__|__|yyyy **Time** 5446: |__|__|hh : |__|__|mm 24 hr ○ N/A
→ Indicate source of **Code Activation** 5447:	○ SAAS ○ Cath Facility ○ Code Not Activated ○ Other
Cath Lab Arrival	**Date** 5448: |__|__|dd |__|__|mm 20|__|__|yyyy **Time** 5449: |__|__|hh : |__|__|mm 24 hr ○ N/A
Wire Across	**Date** 5450: |__|__|dd |__|__|mm 20|__|__|yyyy **Time** 5451: |__|__|hh : |__|__|mm 24 hr ○ N/A
1st Device Activation	**Date** 5452: |__|__|dd |__|__|mm 20|__|__|yyyy **Time** 5453: |__|__|hh : |__|__|mm 24 hr ○ N/A

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Diagnostic Catheterisation and Percutaneous Coronary Intervention Registry

E. DIAGNOSTIC CATHETERISATION PROCEDURE (COMPLETE FOR EACH DIAGNOSTIC CATH)

Supervising Consultant Name 6000 :
Primary Operator Name 6010 :

Left Heart Cath 6025: ○ No ○ Yes **Right Heart Cath** 6026: ○ No ○ Yes
→ If Right Cath Yes, Mean RA Pressure 6027 |__|__|__| mmHg Mean PCW Pressure 6030 |__|__|__| mmHg
Mean PA Pressure 6028 |__|__|__| mmHg Diastolic Arterial BP 6031 |__|__|__| mmHg
Systolic RV pressure 6029 |__|__|__| mmHg Systolic Arterial BP 6032 |__|__|__| mmHg
Cardiac Transplantation Evaluation 6034: ○ No ○ Yes
→ If yes, **Type** 6035: ○ Donor for cardiac transplant ○ Candidate to receive cardiac transplant ○ Post cardiac transplant follow-up
Diagnostic Cath Status 6040: ○ Elective ○ Urgent ○ Emergency ○ Salvage

F. CORONARY ANGIOGRAPHY FINDINGS (COMPLETE FOR EACH CATH LAB VISIT)

BEST ESTIMATE OF CORONARY ANATOMY

Dominance 6100: ○ Left ○ Right ○ Co-dominant ○ Unknown

Coronary Territory	Native Artery Percent Stenosis in ≥ 2mm vessels	Grafts Supplying Coronary Territory Percent Stenosis Note 2
Left Main	|__|__|__| % 6110 ☐ Not Available 6111	
Prox LAD	|__|__|__| % 6120 ☐ Not Available 6121	|__|__|__| % 6170 ☐ Not Available 6171
Mid/Distal LAD, Diag Branches	|__|__|__| % 6130 ☐ Not Available 6131	|__|__|__| % 6180 ☐ Not Available 6181
Circ, OMs, LPDA, LPL Branches	|__|__|__| % 6140 ☐ Not Available 6141	|__|__|__| % 6190 ☐ Not Available 6191
RCA, RPDA, RPL, AM Branches	|__|__|__| % 6150 ☐ Not Available 6151	|__|__|__| % 6200 ☐ Not Available 6201
Ramus	|__|__|__| % 6160 ☐ Not Available 6161	|__|__|__| % 6210 ☐ Not Available 6211
Aberrant	|__|__|__| % 6165 ☐ Not Available 6166	|__|__|__| % 6215 ☐ Not Available 6216

Other Disease Findings 6250: ○ No CAD (smooth) ○ Minor plaques <50% ○ Small Vessel CAD ≥ 50% ○ None
Extent of Coronary Disease 6252: ○ No CAD ○ 1 Vessel Disease ○ 2 Vessel Disease ○ 3 Vessel Disease
→ If 2 VD or 3 VD **Left Main** 6253: ○ No ○ Yes

Principal Cardiac Diagnoses:

Atherosclerotic CAD 6300:	○ No ○ Yes	**Congenital Heart Disease** 6308:	○ No ○ Yes
Slow Flow 6301:	○ No ○ Yes	**1º Pulmonary Hypertension** 6309:	○ No ○ Yes
Variant Angina 6302:	○ No ○ Yes	**Myocarditis** 6310:	○ No ○ Yes
Takotsubo 6303:	○ No ○ Yes	**Pericarditis** 6311:	○ No ○ Yes
Muscle Bridge 6304:	○ No ○ Yes	**Microvascular Disease** 6312:	○ No ○ Yes
Cardiomyopathy 6305:	○ No ○ Yes	**Spasm** 6313:	○ No ○ Yes
Valvular Heart Disease 6306:	○ No ○ Yes		
Spontaneous Coronary Dissection 6307:	○ No ○ Yes		
Other 6315:	○ No ○ Yes	→ If yes, Indicate 6316: _____	

Rx Recommendation 6045: (after diagnostic cath) ○ None ○ Medical therapy and/or counseling ○ PCI w/o planned CABG ○ CABG (including planned hybrid CABG/PCI procedures) ○ Other cardiac therapy without CABG or PCI

Note 2: CABG Date 6020 must be less than or equal to Procedure Date/Time 5300/5301 or Prior CABG 4045 = "Yes" to complete these elements

APPENDIX A (CONTINUED)

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G. PCI PROCEDURE (COMPLETE FOR EACH CATH LAB VISIT IN WHICH A PCI WAS ATTEMPTED OR PERFORMED)

Supervising Consultant Name [7000]:	
Primary Operator Name [7010]:	
PCI Status [7020]:	○ Elective ○ Urgent ○ Emergency ○ Salvage
Pre-PCI LVEF [7025]:	|__||__| % ☐ Pre-PCI LVEF Not Assessed [7026] — Cardiogenic Shock at start of PCI [7030]: ○ No ○ Yes
PCI Indication [7035]:	○ Immediate PCI for STEMI ○ PCI for STEMI (Unstable, >12 hrs from Sx onset) ○ PCI for STEMI (Stable, >12 hrs from sx onset) ○ PCI for STEMI (stable after successful full-dose thrombolysis) ○ Rescue PCI for STEMI (after failed full-dose lytics) ○ PCI for high risk NSTEMI or unstable angina ○ Staged PCI ○ Other

If Immediate PCI for STEMI:

Non-system reason for Delay in PCI [7036]:
○ Difficult vascular access ○ Cardiac arrest and/or need for intubation before PCI
○ Patient delays in providing consent for procedure ○ Difficulty crossing the culprit lesion during the PCI procedure
○ Other ○ None

PART H. LESIONS AND DEVICES (COMPLETE FOR EACH PCI ATTEMPTED OR PERFOMRED)

Lesion Counter [7100]:	1	2
Segment Number(s) [7105]:	___, ___, ___, ___, ___,	___, ___, ___, ___, ___,
If CAD Presentation [5000] is STEMI, NSTEMI or Unstable Angina, indicate if Culprit Lesion [7110]:	○ No ○ Yes ○ Unknown	○ No ○ Yes ○ Unknown
Stenosis immediately Prior to Rx [7105]:	|__||__||__|%	|__||__||__| %
→ If 100%, Chronic Total Occulsion [7120]:	○ No ○ Yes	○ No ○ Yes
→ If 40-70%, IVUS [7125]:	○ No ○ Yes	○ No ○ Yes
→ If 40-70%, FFR [7130]:	○ No ○ Yes	○ No ○ Yes
→ If Yes, FFR Ratio [7135]:	|__|.|__||__|	|__|.|__||__|
Pre-procedure TIMI Flow [7140]:	○ 0 ○ 1 ○ 2 ○ 3	○ 0 ○ 1 ○ 2 ○ 3
Previously Treated Lesion [7145]:	○ No ○ Yes	○ No ○ Yes
→ If Yes, Time Frame [7150]:	○ < 1month ○ 1-6 months ○ 6-12 months ○ 1-2 years ○ > 2 years ○ Unknown	○ < 1month ○ 1-6 months ○ 6-12 months ○ 1-2 years ○ > 2 years ○ Unknown
→ If Yes, Treated with Stent [7155]:	○ No ○ Yes	○ No ○ Yes
→ If Yes, In-Stent Restenosis [7160]:	○ No ○ Yes	○ No ○ Yes
In-Stent Thrombosis [7165]:	○ No ○ Yes	○ No ○ Yes
Stent Type [7170]:	○ DES ○ Non-DES ○ Unknown	○ DES ○ Non-DES ○ Unknown
Lesion in Graft [7175]:	○ Not in Graft ○ Vein ○ LIMA ○ Other	○ Not in Graft ○ Vein ○ LIMA ○ Other
→ If Vein, LIMA or Other, Location in Graft [7180]:	○ Aortic ○ Body ○ Distal	○ Aortic ○ Body ○ Distal
Lesion Complexity [7185]:	○ Non-High/Non-C ○ High/C	○ Non-High/Non-C ○ High/C
Lesion Length (mm) [7190]:	|__||__| mm	|__||__| mm
Thrombus Present [7195]:	○ No ○ Yes	○ No ○ Yes
Bifurcation Lesion [7200]:	○ No ○ Yes	○ No ○ Yes
Guidewire Across Lesion [7205]:	○ No ○ Yes	○ No ○ Yes
→ If Yes, Stenosis Post-Procedure [7210]:	|__||__| %	|__||__| %
→ If Yes, Post-procedure TIMI Flow [7215]:	○ 0 ○ 1 ○ 2 ○ 3	○ 0 ○ 1 ○ 2 ○ 3
→ If Yes, Device(s) Deployed [7220]:	○ No ○ Yes	○ No ○ Yes
→ If Device Deployed Yes,		
Device 1 — Intracoronary Device Used [7225]:	_____ Device Name & Type	_____ Device Name & Type
Device Diameter [7235]:	|__||__| . |__||__| mm	|__||__| . |__||__| mm
Device Length [7240]:	|__||__||__| mm	|__||__||__| mm
Device 2 — Intracoronary Device Used [7225]:	_____ Device Name & Type	_____ Device Name & Type
Device Diameter [7235]:	|__||__| . |__||__| mm	|__||__| . |__||__| mm
Device Length [7240]:	|__||__||__| mm	|__||__||__| mm

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PART H. LESIONS AND DEVICES (COMPLETE FOR EACH PCI ATTEMPTED OR PERFOMRED)

Lesion Counter [7100]:	1	2
→ Intracoronary Devices (continued)		
Device 3 — Intracoronary Device Used [7225]:	_____ Device Name & Type	_____ Device Name & Type
Device Diameter [7235]:	|__||__| . |__||__| mm	|__||__| . |__||__| mm
Device Length [7240]:	|__||__||__| mm	|__||__||__| mm
Device 4 — Intracoronary Device Used [7225]:	_____ Device Name & Type	_____ Device Name & Type
Device Diameter [7235]:	|__||__| . |__||__| mm	|__||__| . |__||__| mm
Device Length [7240]:	|__||__||__| mm	|__||__||__| mm

INTRAPROCEDURE EVENTS (COMPLETE FOR EACH PCI ATTEMPTED OR PERFOMRED)

Significant Dissection [7245]: ○ No ○ Yes — Perforation [7250]: ○ No ○ Yes — No Re-flow [7255]: ○ No ○ Yes

PART I. PROCEDURE MEDICATIONS (COMPLETE FOR EACH CATH LAB VISIT)
(ADMINISTERED WITHIN 24 HOURS PRIOR TO AND DURING CATH PROCEDURE)

Category	Medication [9500]	Administered [9510]	Route [9511]
Anticoagulants	Low Molecular Weight Heparin (any)	○ No ○ Yes ○ Contraindicated ○ Blinded	○ IV ○ IC ○ Other
	Unfractionated Heparin (any)	○ No ○ Yes ○ Contraindicated ○ Blinded	○ IV ○ IC ○ Other
Aspirin	Aspirin (any)	○ No ○ Yes ○ Contraindicated ○ Blinded	○ IV ○ IC ○ Other
	Bivalrudin	○ No ○ Yes ○ Contraindicated ○ Blinded	○ IV ○ IC ○ Other
Direct Thrombin Inhibitors	Direct Thrombin Inhibitor (other)	○ No ○ Yes ○ Contraindicated ○ Blinded	○ IV ○ IC ○ Other
Glycoprotein IIb/Iia Inhibitors	GP IIb/IIa (any)	○ No ○ Yes ○ Contraindicated ○ Blinded	○ IV ○ IC ○ Other
Thienopyridines	Clopidogrel	○ No ○ Yes ○ Contraindicated ○ Blinded	○ IV ○ IC ○ Other
Other Agents	Glyceryl Trinitrate	○ No ○ Yes ○ Contraindicated ○ Blinded	○ IV ○ IC ○ Other
	Adenosine	○ No ○ Yes ○ Contraindicated ○ Blinded	○ IV ○ IC ○ Other
	Verapamil	○ No ○ Yes ○ Contraindicated ○ Blinded	○ IV ○ IC ○ Other
	Atropine	○ No ○ Yes ○ Contraindicated ○ Blinded	○ IV ○ IC ○ Other
	Aramine	○ No ○ Yes ○ Contraindicated ○ Blinded	○ IV ○ IC ○ Other
	Inotropes	○ No ○ Yes ○ Contraindicated ○ Blinded	○ IV ○ IC ○ Other
	Ticagrelor	○ No ○ Yes ○ Contraindicated ○ Blinded	○ IV ○ IC ○ Other
	Prasugrel	○ No ○ Yes ○ Contraindicated ○ Blinded	○ IV ○ IC ○ Other

PART J. LABS (COMPLETE FOR EACH CATH LAB VISIT)

Pre-Procedure (performed at your facility)	Post-Procedure (post procedure only)
CK-MB [7300] __ __ __ ug/L ☐ CK-MB Not Applicable [7301] ☐ CK-MB Drawn & Normal [7302]	CK-MB [7325] __ __ __ ug/L ☐ CK-MB Not Applicable [7326] ☐ CK-MB Drawn & Normal [7327] — Peak value 6-24 hrs
Troponin T [7310] __ __ __ ng/L ☐ Not Drawn [7311] ☐ TnT drawn & Normal [7312]	Troponin T [7335] __ __ __ ng/L ☐ Not Drawn [7336] ☐ TnT drawn & Normal [7337] — Peak value 6-24 hrs
Creatinine [7315] __ __ __ umol/L ☐ Not Drawn [7316]	Creatinine [7340] __ __ __ umol/L ☐ Not Drawn [7341] — Highest value
Haemoglobin [7320] __ __ __ g/L ☐ Not Drawn [7321]	Haemoglobin [7345] __ __ __ g/L ☐ Not Drawn [7346] — Lowest within 72 hrs

PART K. INTRA and POST-PROCEDURE EVENTS (COMPLETE FOR EACH CATH LAB VISIT)

Myocardial Infarction [8000]: (Positive Biomarkers)	○ No ○ Yes	Bleeding Event w/in 72 Hours [8050]:	○ No ○ Yes
Cardiogenic Shock [8005]:	○ No ○ Yes	→ If Yes, Bleeding at Access Site [8055]:	○ No ○ Yes
Heart Failure [8010]:	○ No ○ Yes	→ If Yes, Haematoma at Access Site [8060]:	○ No ○ Yes
CVA/Stroke [8015]:	○ No ○ Yes	→ If Yes, Size [8061]:	○ < 3cm ○ 3-5cm ○ >5<10cm ○ > 10cm
→ If Yes, Haemorrhagic Stroke [8020]:	○ No ○ Yes	→ If Yes, Retroperitoneal Bleeding [8070]:	○ No ○ Yes
Tamponade [8025]:	○ No ○ Yes	→ If Yes, GI Bleed [8080]:	○ No ○ Yes
New Requirement for Dialysis [8030]:	○ No ○ Yes	→ If Yes, GU Bleed [8090]:	○ No ○ Yes
Other Vascular Complications Requiring Rx [8035]:	○ No ○ Yes	→ If Yes, Other Bleed [8100]:	○ No ○ Yes
RBC/Whole Blood Transfusion [8040]:	○ No ○ Yes	Bleeding Status [8200]: (At time of Discharge from Cath Facility)	
→ If Yes, Hgb Prior to Transfusion [8041]:	__ __ __ g/L	Type 0 ○ Type 1 ○ Type 2 ○ Type 3 ○ Type 4 ○ Type 5 ○	
Atrial Fibrillation [8205]:	○ No ○ Yes	Mechanical Support [8225]:	○ No ○ Yes
VTach/VFib [8210]:	○ No ○ Yes	Contrast Allergy [8230]:	○ No ○ Yes
Cardiac Arrest [8215]:	○ No ○ Yes	Cholesterol Emboli [8235]:	○ No ○ Yes
Defibrillation [8220]:	○ No ○ Yes		

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PART L. DISCHARGE (COMPLETE THIS SECTION FOR EACH EPISODE OF CARE)

CABG [9000]:	○ No ○ Yes
→ If Yes, CABG Status [9005]:	○ Elective ○ Urgent ○ Emergency ○ Salvage
→ If Yes, CABG Indication [9010]:	○ PCI complication ○ PCI failure without clinical deterioration ○ Treatment of CAD without PCI immediately preceding CABG ○ PCI/CABG hybrid procedure
→ If Yes, Procedure Location [9015]:	○ At this facility ○ Transferred to other facility
→ If At this facility, CABG Date/Time [9020, 9021]:	|__||__|dd |__||__|mm 20|__||__|yyyy |__||__|hh : |__||__|mm 24 hr
Other Major Surgery [9025]:	○ No ○ Yes
LVEF [9030]:	|__||__| % ☐ LVEF Not Assessed [9301]
Participant in Clinical Trial [9032]:	○ No ○ Yes ○ Unknown
Discharge Date [9035]:	|__||__|dd |__||__|mm 20|__||__|yyyy
Discharge Status [9040]:	○ Alive ○ Deceased
→ If Alive, Discharge Location [9045]:	○ Home ○ Other acute care hospital ○ Hospice ○ Nursing Home ○ Extended care/TCU/rehab ○ Left against medical advice ○ Other
→ If Alive, Cardiac Rehabilitation Referral [9050]:	○ No ○ Yes ○ Ineligible ○ Unknown
→ If Alive, Smoking Counselling [9051]:	○ No ○ Yes
→ If Deceased, Death in Cath Lab [9055]:	○ No ○ Yes
→ If Deceased, Primary Cause of Death [9060]:	○ Cardiac ○ Neurologic ○ Renal ○ Vascular ○ Infection ○ Valvular ○ Pulmonary ○ Unknown ○ Other
Hospital Status [9065]:	○ Outpatient ○ Outpatient converted to inpatient ○ Inpatient

DISCHARGE MEDICATIONS: (PRESCRIBED AT DISCHARGE – COMPLETE FOR EACH EPISODE OF CARE) (Additional Medication Page Attached ☐)

Cardiovascular Medications	No	Yes	Contra	Unk	Generic Name [9066]:	Dose [9067, 9068]:	Freq. [9069]:
Anti-platelet agents [9075]:	○	○	○	○			
Second Anti-platelet agent [9076]:	○	○	○	○			
Injectable Anti-coagulants [9077]:	○	○	○	○			
Oral Anti-coagulants [9078]:	○	○	○	○			
Statin [9079]:	○	○	○	○			
Non-Stain Lipid Lowering Agent [9080]:	○	○	○	○			
ACE Inhibitor [9081]:	○	○	○	○			
Angiotensin Receptor Blocker [9082]:	○	○	○	○			
Calcium Channel Blocker [9083]:	○	○	○	○			
Beta Blocker [9084]:	○	○	○	○			
Long-Acting Nitrate/Anti Angina Agent [9085]:	○	○	○	○			

Other Medications [9097]: ○ No ○ Yes ○ Unknown → If yes, complete below

Type [9098]:	Generic Name [9099]:	Dose [9100, 9101]:	Freq. [9102]:	Therapeutic Class [9103]:
○ Cardiovascular ○ Non-Cardiovascular				
○ Cardiovascular ○ Non-Cardiovascular				
○ Cardiovascular ○ Non-Cardiovascular				
○ Cardiovascular ○ Non-Cardiovascular				
○ Cardiovascular ○ Non-Cardiovascular				
○ Cardiovascular ○ Non-Cardiovascular				
○ Cardiovascular ○ Non-Cardiovascular				
○ Cardiovascular ○ Non-Cardiovascular				
○ Cardiovascular ○ Non-Cardiovascular				
○ Cardiovascular ○ Non-Cardiovascular				

RECORD COMPLETE [9105] ☐ — Completed by: — Staff Initial: [9110] — Date of Data Entry: [9115]

APPENDIX B

Style Guidelines for The European Heart Journal

Author guidelines can be found via: https://academic.oup.com/eurheartj/pages/General_Instructions

Word Count	All submitted manuscripts must not exceed 5000 words (or for Current Opinions 2500 words, Editorials 1500 words and Correspondence 500 words), including tables, figure legends, and references. The number of tables and figures should be appropriate to the manuscript content and should not be excessive in number.
Style and Spelling	Oxford English spelling should be used. Authors whose first language is not English are requested to have their manuscripts checked carefully before submission. This will greatly help expedite the review process by helping to ensure that the academic content of the paper is fully understood by journal editors and reviewers. There are many specialist language editing companies that offer editing services and you can use any of these. Authors are liable for all costs associated with such services.
Abbreviations	Standard SI units of measurement should only be used.
Sections of the manuscript	Clinical and Basic Science papers should be divided into the following sections: (1) Title page, (2) Abstract and Keywords, (3) Translational Perspective (translational aspects; applicable only for Basic Science papers), (4) Introduction, (5) Methods, (6) Results, (7) Discussion, (8) Acknowledgements, (9) References, (10) Figure legends, (11) Appendices, (12) Text tables, (13) Figures, and (14) Supplementary files (if any).
General format	Prepare the manuscript text using a Word processing package (save in .doc format). Submission of PDF text files is not permitted. Manuscripts should be double-spaced, including text, tables, legends, and references. Each page should be consecutively numbered and all pages must contain line numbers that restart at each page . Please avoid footnotes; use instead, and as sparingly as possible, parentheses within brackets. Enter text in the style and order of the journal. Type references in the correct order and style of the journal (see Reference Format below). Type unjustified, without hyphenation, except for compound words, and type headings in the style of the journal. Use the TAB key once for paragraph indents. Where possible, use Times New Roman for the text font and Symbol for the Greek and special characters. Use the word processing formatting features to indicate Bold, Italic, Greek, Maths, Superscript, and Subscript characters. Clearly identify unusual symbols and Greek letters. Differentiate between the letter “O” and zero, and the letter “I” and the number 1. Mark the approximate position of each figure and table. Check the final copy of your paper carefully since any spelling errors may be retained in a typeset version.
Title page	The title page should include the following: (1) the title, (2) the name(s) of authors, (3) the institution(s) where the work was performed, (4) the position, institution, and location of all authors, (5) the telephone number, fax number, and e-mail address of the corresponding author, (6) the institutional affiliations of the authors (including corporate appointments) should be acknowledged in a footnote.
Abstract	All abstracts must be restricted in length to 250 words and should also be submitted as a separate file (for administrative purposes only). The abstract should be formatted with the following headings: (1) Aims, (2) Methods and Results, (3) Conclusion, (4) Keywords. A maximum of six keywords may be submitted.
Tables	Tables should be typed with double spacing, but minimizing redundant space, and each table should be uploaded as a separate file. Wherever possible, tables should be submitted in portrait - as opposed to landscape - layout. Each table should be numbered in sequence using Arabic numerals. Tables should also have a title above and an explanatory footnote below.
Figures	Figures should be limited to the number necessary for clarity and must not duplicate data given in tables or in the text. Standard submissions should have no more than 8 total figures and tables. Any number exceeding this should be designated as supplementary online-only material. They must be suitable for high quality reproduction and should be submitted in the desired final printed size so that reduction can be avoided. Figures should be no larger than 125 (height) x 180 (width) mm (5 x 7 inches) and should be submitted under the respective header (“Figure”) and in files separates from that of the main manuscript.