

**EVIDENCE BASED PRACTICE**

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**Silent Myocardial Ischaemia:  
A Review of the Literature for Prehospital Care Providers**

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**Abstract**

**Background**

There has been little emphasis in paramedic education about silent myocardial ischaemia, its implications, and management in the prehospital environment. There is also inadequate information about the aetiology and prehospital management of silent myocardial infarction. The objective of this study was to review the literature on silent myocardial ischaemia and determine appropriate prehospital management.

**Methods**

A review of the Medline database was conducted from 1950 to the beginning of March 2007. Inclusion criteria were, any study type reporting the epidemiology, pathophysiology, clinical concepts, and management of silent myocardial ischaemia. References of relevant articles were also reviewed. A review of prehospital clinical implications and management was also undertaken.

**Results**

The search yielded 1,332 articles; 110 articles met the inclusion criteria with another 32 articles located from review of relevant articles reference list. Silent myocardial ischaemia is not limited to patients with significant coronary artery disease or cardiovascular risk profiles, it may affect up to 10% of patients with asymptomatic coronary artery disease. Silent myocardial ischaemia is also associated with greater adverse outcomes, and has been defined as the single strongest factor attributing to cardiac death in patients with concurrent angina pectoris. All patients with coronary artery disease presenting with and without pain can be managed with GTN and aspirin, in the absence of contra-indications.

**Conclusion**

This study demonstrates that silent myocardial ischaemia is not limited to patients with significant cardiovascular risk profiles and may affect up to 10% of patients with asymptomatic coronary artery disease. There is little prehospital care providers can achieve with current clinical practice guidelines and management regimes.

## **Keywords**

angina; angina pectoris; chest pain; emergency medical services; emergency medical technicians; myocardial infarction; myocardial ischemia.

## **Background**

Silent Myocardial Ischaemia (SMI) represents an evolutionary discovery for coronary care physicians. For decades, researchers have been intrigued by the elusive mechanisms involved in the ischaemic process that produces no associated pain. While there remains insubstantial evidence to clearly identify the underlying cascade of events interrupting an effective anginal warning signal, many population-based clinical studies have associated poorer prognostic outcomes for patients with the underlying aetiology. The role of clinical and therapeutic interventions therefore proves fundamental in the management of SMI in both hospital and prehospital arenas. However, there appears to be a lack of prehospital literature defining the clinical presentation and management of SMI. There has not been a previous study that focuses on the classification, identification and management of SMI, including a review of prehospital pharmacology to manage SMI. The objective of this study was to review the literature on silent myocardial ischaemia and determine appropriate prehospital management.

## **Methods**

A review of the literature was conducted using the OVID Medline electronic database. Medline was searched from 1950 until the 1<sup>st</sup> March 2007.

The Medical Subject Heading (MeSH) headings used in the search were: ambulance, air ambulance, prehospital care, emergency medical services, emergency medical technician, myocardial ischemia; myocardial infarction; angina pectoris, angina, unstable, and chest pain. Keywords used were: out-of-hospital, out of hospital, prehospital, paramedic, military medicine, ischaemia, silent, asymptomatic, atypical, unrecognised, unrecognized, painless, implications, management, treatment. The MeSH headings and keywords were used individually and in combination during the search process. All search results were then combined to remove duplicates and provide a list of articles for review. The references from articles gathered were reviewed to identify additional articles not found in the electronic database search.

Articles of any study type were considered relevant if they contained information pertaining to the epidemiology, pathophysiology, clinical concepts and interventions for silent myocardial ischaemia in the prehospital or hospital setting. Articles were excluded if they were not in English, were editorials, letters or news.

## **Results**

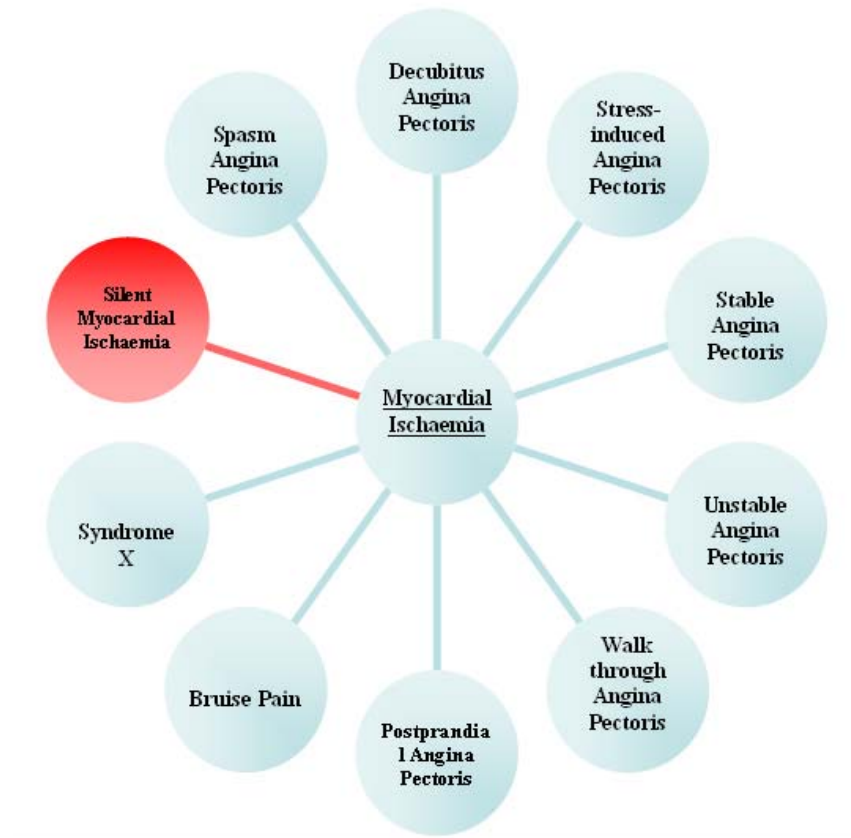
The electronic database search cited just over 1,332 articles for review. Of these articles 110 met the inclusion criteria, with another 32 articles located by reviewing the reference lists of the articles meeting the inclusion criteria. No articles were found that related to the aetiology and management of SMI in the prehospital setting.

## **Discussion**

### ***Classification and Prevalence of Silent Myocardial Ischaemia***

SMI contributes to an already complex spectrum of elusive ischaemic mechanisms (Figure 1). In 1912, James Herrick discovered that myocardial ischaemia and pain were not synonymous in nature; rather, pain was a discriminate and unpredictable feature of myocardial ischaemia that could propose a threat for patients and their physicians.<sup>1</sup> Research papers that followed reported similar notions with major difficulties in the classification, recognition, diagnosis and treatment of myocardial ischaemia.

Figure 1: Spectrum of Myocardial Ischaemia



SMI is not exclusive to populations with symptomatic Coronary Artery Disease (CAD). In fact, patients with no history of myocardial infarction or angina pectoris, have been found to exhibit characteristic ST segment changes and T-wave abnormalities during exercise stress testing without the usual complaint of pain.<sup>2</sup> Considering its variability in nature and the likely prognostic differences for each sub-group of patients, Cohn recommended that SMI be classified under three patient presentations (Table 1).<sup>2</sup> It is important to note however that each clinically defined group gives rise to subgroups that will naturally have an increased risk and others with a lower risk for silent ischaemia and adverse outcome.<sup>3</sup>

Table 1: Classification of Silent Myocardial Ischaemia<sup>2</sup>

| Type | Definition   |
|------|--|
| 1    | Patients with asymptomatic CAD and no history of myocardial infarction or angina pectoris, but exhibit silent ischaemic episodes as detected by exercise stress testing. |

|   |   |
|---|---|
| 2 | Patients who have had a myocardial infarction, but have remained asymptomatic since then, and exhibit silent ischaemic episodes as detected by exercise stress testing. |
| 3 | Patients with frequent anginal episodes and concurrently experience silent ischaemia as detected by exercise stress testing.  |

### **Type 1 - Silent Myocardial Ischaemia**

The literature suggests that SMI may well affect between 2.5% to 10% of the population before they are symptomatically aware of any underlying coronary artery malformations.<sup>4-8</sup> However, a recent study by Anand et al. investigated 864 asymptomatic individuals with the use of electron beam tomography coronary calcium imaging and found that 18% of patients with moderate and 45% with severe atherosclerosis experienced episodes of silent ischaemia.<sup>9</sup> As discussed earlier, this increase may reflect the differing risk factor profiles of sample populations, whereby, the mean number of risk factors may have been significantly higher in this study.

### **Type 2 - Silent Myocardial Ischaemia**

SMI is a significant predictor of death and re-infarction in post myocardial infarction patients.<sup>10-12</sup> Ouyang et al. investigated 59 uncomplicated post infarction patients that underwent electrocardiography monitoring 4 days after admission, and found that 46% of these patients experienced asymptomatic daily life ischaemia.<sup>11</sup> Fifty-two percent of patients experienced further cardiac events (death or post infarction angina or acute pulmonary oedema), while in comparison only 22% of patients without silent ischaemia experienced cardiac related events. Angiography revealed similar degrees of CAD in both populations. Narins et al. went on to make the comparison that patients with painless ischaemic episodes during stress testing 1 to 6 months post coronary event (unstable angina or myocardial infarction) had superior left ventricular wall function and fewer recurring cardiac events than those with symptomatic ischaemia.<sup>13</sup>

### **Type 3 - Silent Myocardial Ischaemia**

The incidence of SMI in patients who experience regular episodes of angina pectoris varies considerably in the literature from 40% to 90%.<sup>14-20</sup> In addition, Deedwania and Carbajal highlighted that from 107 stable angina patients who underwent ambulatory electrocardiography monitoring, SMI was the most powerful and independent predictor of cardiac mortality and poor prognostic outcome.<sup>21</sup> It is also important to note that the majority of ischaemic episodes in this population manifest silently.<sup>16</sup>

### **Risk Factors**

The prevalence of SMI in patients with underlying CAD is variably influenced by the number of risk profiles associated with each patient. For example, studies correlating diabetes to SMI have found a considerably higher incidence of silent ischaemia among this population.<sup>22-27</sup>

While much pertaining to the underlying mechanism remains to be debated, it has been hypothesised that peripheral autonomic neuropathy is the most likely cause of increased SMI in this sub group. A recent study by Falcone and colleagues may support this hypothesis

through an investigation of 618 diabetic (with asymptomatic neuropathy) and non-diabetic patients with CAD and risk profile matching.<sup>28</sup> While diabetics reported greater episodes of angina, there was no significant difference in the incidence of SMI between both groups. This may prove that only diabetic populations with confirmed symptomatic autonomic neuropathies are exposed to the increased risk of SMI.

Common risk factors for CAD have also been noted to have a greater incidence of SMI and adverse outcomes. These include: unstable angina, hyperlipidemia, hypertension, diabetes, elderly patients, smoking and family history of premature CAD. The female gender has also been attributed to an increased risk of SMI.<sup>9</sup>

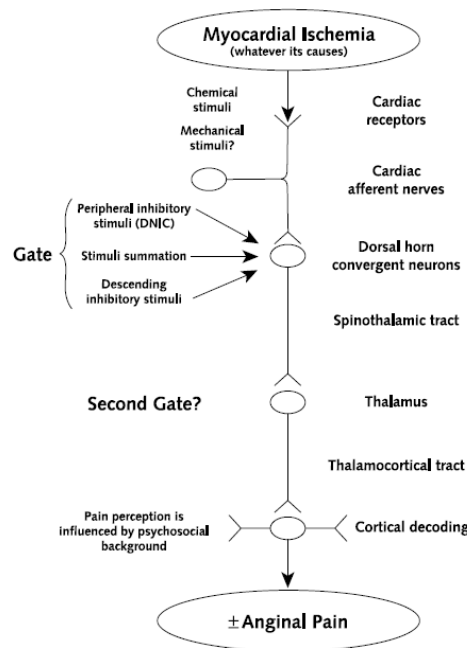
### ***Pathophysiology of Silent Myocardial Ischaemia: The Notion of a Defective Anginal Warning Signal***

The precipitating events that lead to myocardial ischaemia have long been defined as a process of CAD secondary to the vascular formation of atherosclerosis. An imbalance between the oxygen supply and demand of cardiac myocytes during increased states of work is the primary cause of myocardial ischaemia, and is now widely accepted to play the same role in SMI.<sup>3</sup> The hemodynamic and perfusion demand properties of the heart have demonstrated through clinical trials that SMI is truly an ischaemic event<sup>5, 29-31</sup>; a lesson that was learnt over two decades ago.

The stimulation of free nerve endings in the myocardium produces the individual's pain perception through a series of complex, and still not well defined, autonomic pathways. This involves the stimulation of sympathetic nerve endings and the propagation of impulses through cardiac afferent nerves, the dorsal horn convergent neurons, and through to the thalamus and cerebral cortex for decoding and interpretation (Figure 2).<sup>32</sup> The excitation of these nerve endings most likely involves two predominant stimuli: 1) chemical mediators released as a response to the overwhelming effect of hypoxia on cardiac myocytes or; 2) mechanical factors associated with changes in cellular tone induced by the ischaemic event or; 3) both.

SMI introduces an interesting physiological challenge when trying to reflect on the 'cause and effect' relationship between tissue damage and pain as an organism's primary protective value. While this principle has shown to be useful in somatic injuries, it is defective when warning the brain of potential injury-causing episodes with SMI. As a result, significant controversies into the elusive mechanisms of silent ischaemia have arisen throughout time. Select few have retained popular interest.

**Figure 2:** Steps in the development, progression, and perception of myocardial ischemia<sup>32</sup>  
 (Reproduced with permission of Elsevier, Copyright Elsevier)



### Individual Adaptation (Increased Pain Threshold)

It has been theorised that pain perception is an individual quality that is subject to psychosocial, physical and physiological adaptations on an individual basis. Pain investigations on sufferers of silent ischaemia have revealed some fascinating results. Several researchers demonstrated that pain threshold and tolerance were significantly higher in patients with SMI, than in those without.<sup>33-36</sup> These studies looked at three basic tests: 1) forearm ischemia induced by tourniquet; 2) standard cold pressor test and; 3) electrical nerve stimulation. This theory may further be linked to studies that have reported a higher incidence of SMI with an increase in age.<sup>37</sup>

### Autonomic Dysfunction

Autonomic alternations are the result of several underlying disease processes resulting in the death of nerve tissue and the subsequent reduction in nerve stimulation. This theory centres primarily on the autonomic neuropathies associated with the diabetic patient to justify the increased frequency of silent attacks in this sub-group. Diabetic patients are up to seven times more likely to experience SMI than non-diabetic patients.<sup>25-27, 38</sup> Studies have also made the link between diabetes mellitus and heightened somatic thresholds.<sup>33,39</sup> Another hypothesis accommodates this theory to patients with type 2 SMI, where by, myocardial pain receptors are destroyed as a result of a previous infarct.<sup>3</sup>

### Quantitative Theory

The size of ischaemia and its correlation with pain intensity has received careful examination in past studies. One hypothesis centres on pain being the result of excessive myocardial receptor stimulation which exceeds a set threshold. This would suggest that patients who experience pain during their ischaemic episodes are most likely suffering from larger areas of myocardial ischaemia than those who do not experience any pain. This concept aligns comfortably with a study that investigated 310 asymptomatic episodes of ST depression in 20

patients, whereby 72% of all episodes occurred during very light or sedentary activity such as sleeping or sitting at ease.<sup>40</sup>

### **Gate Mechanisms (Gate-Control Theory)**

The gate-control theory was first described by Melzack and Wall in 1965.<sup>41</sup> Afferent signals converge onto gates (Figure 2), situated at the dorsal horn of the spinal cord and in the thalamus, and compete with other incoming impulses for interpretation by pain centres in the thalamus.<sup>42</sup> Higher brain centres are responsible for prioritisation of these messages by delivering an equal descending inhibitory stimulus that suppresses incoming signals that are not perceived as acutely beneficial. An imbalance in this equilibrium is set to reveal the perception of pain.<sup>42</sup> This theory suggests that pain centres may focus on another aspect of sensory mechanisms during SMI such as dyspnoea.<sup>43</sup>

### ***Establishing a link with Prehospital Emergency Care***

Lumley and colleagues hypothesised that patients who experience SMI have significantly fewer primary care visits and decreased health care use than patients who experience anginal episodes.<sup>44</sup> The investigation considered emergency services use by both angina and SMI patients during treadmill testing and concluded that patients with SMI have a generalised reduction in somatic awareness and symptom reporting.<sup>44</sup> Another study also observed that patients with silent ischaemia tend to be less affected by psychological factors such as pain and sensation, than those who experience angina pectoris.<sup>45</sup> In addition, patients with a substantial medical history tend to be more psychologically aware of symptom manifestations, and hence, promptly seek medical assistance.<sup>46</sup>

The majority of out-of-hospital myocardial ischaemia presents asymptotically, and therefore an appropriate trigger for the patient's conscious perception of risk or threat may be absent in many of these presentations.<sup>15</sup> It can be argued that a large portion of these patients go on with their daily lives without any catalyst for seeking medical assistance, and thus prehospital emergency care is limited or non-existent for these patients. So who exactly is the prehospital targeted patient in relation to SMI? It is important to state from the onset that all patients are exposed to some risk of silent ischaemic attacks; regardless of the patient's relevant cardiovascular risk profile. Ideally, the role of the prehospital care provider is focused at investigating potential secondary manifestations of SMI rather than looking for a cardiac-specific symptom. These secondary manifestations involve changes in the patient's physiological state that may indicate poor ventricular function, i.e. dyspnoea, syncope, fatigue, dizziness, heart failure, electrocardiography abnormalities, atypical discomfort, palpitations, belching, emesis or other anginal equivalent symptoms. These presentations may manifest in both the patient with symptomatic cardiovascular co-morbidities, or in the asymptomatic CAD patient. A meaningful history leading up to the primary complaint may prove vital when developing a basis of suspicion of underlying myocardial ischaemia.

### ***Implications for Prehospital Management***

Silent myocardial ischaemia poses several problems for both the patient and the prehospital care provider. Herrick in 1912 made the connection immediately after discovering that "[some] cases with obstruction did not show anginal pain... nausea and vomiting, with belching of gas, are common... ashy countenance, cold sweat and feeble pulse complete the picture of collapse. The attention of the patient and the physician as well may, therefore, be strongly focused on the abdomen... [while the] cardiac origin may be the more easily

*overlooked when there has been no previous typical angina...*"<sup>1</sup> Therefore, the assessment and diagnosis of prehospital acute myocardial infarction and myocardial ischaemia can be difficult in the absence of typical clinical features. SMI and silent acute myocardial infarction for example, may present with anginal equivalent symptoms such as dyspnoea and heart failure in the absence of classic retrosternal chest pain.<sup>47</sup> In these presentations the use of equipment such as the electrocardiogram is ever so important, and the ability to correctly interpret cardiac waveforms under particular aetiologies becomes an art, rather than a skill. Furthermore the use of anti-ischaemic medications such as smooth muscle vasodilators and anti-thrombolytic agents become enhanced, preventing myocardial ischaemia and encouraging early cellular reperfusion.

### **Electrocardiography monitoring**

In the absence of pain or anginal equivalents, the in-hospital diagnosis of silent ischaemia is made through direct and indirect measurement/interpretation of left ventricular function, perfusion demand properties, metabolism, and electrical activity.<sup>48</sup> A general rule for a positive result of myocardial ischaemia on the ECG is ST segment depression of at least 1.0mm, 80msec after the J point and lasting at least 60 seconds. This rule may serve useful to prehospital care providers when presented with irregular clinical features of angina pectoris. However, the interpretation of ST segment depression and/or T-wave inversion alone is not always suggestive of underlying myocardial ischaemia (Table 3). Changes in cardiac waveforms indicative of myocardial ischaemia have been shown to serve false-positive results in some patients.<sup>49-51</sup> Waveform interpretations should therefore complement the patient's physiological assessment, rather than in itself being the only piece of evidence towards diagnosis and subsequent management. Perfusion studies have shown that most positive SMI results from exercise stress testing are followed by an increase in heart rate and blood pressure. In addition to changes of vital signs, the patient's history may serve useful in establishing the duration and onset of atypical symptoms such as dyspnoea, palpitations, fatigue, belching, and discomfort.<sup>49, 52, 53</sup>

Table 3: Differential diagnosis of ST segment depression and/or T-wave inversion<sup>54</sup>

| Cause                                 | ST Segment Depression  | T-wave Inversion  |
|---------------------------------------|--|---|
| Artefact or normal variation          | <ul style="list-style-type: none"> <li>• Pseudo-ST segment depression (poor skin-electrode contact, or body movement during monitoring can cause a wandering baseline)</li> <li>• Atrial repolarization</li> <li>• Hyperventilation-induced ST segment depression</li> </ul>   |   |
| Ischaemic Heart Disease               | <ul style="list-style-type: none"> <li>• Cardiomyopathy</li> <li>• Subendocardial ischaemia</li> <li>• Non-STEMI</li> <li>• Reciprocal ST segment changes in STEMI</li> </ul>  | <ul style="list-style-type: none"> <li>• Mitral valve prolapse</li> <li>• Subacute pericarditis</li> <li>• STEMI</li> <li>• Non-STEMI</li> <li>• Myocardial ischaemia</li> <li>• Myocarditis</li> </ul>   |
| Non-ischaemic causes of ST depression | <ul style="list-style-type: none"> <li>• Electrolyte abnormalities</li> <li>• Hypokalemia</li> <li>• Right Ventricular Hypertrophy (right precordial leads) or Left Ventricular Hypertrophy (left precordial leads, lead I &amp; aVL)</li> <li>• Digoxin side effect</li> <li>• Psychostimulant drug use (i.e. cocaine)</li> <li>• Mitral valve prolapse</li> <li>• Secondary ST segment changes with IV conduction abnormalities (e.g., RBBB, LBBB, WPW, etc)</li> <li>• CNS Disease</li> </ul> | <ul style="list-style-type: none"> <li>• Myocardial contusion (trauma)</li> <li>• Digoxin side effect</li> <li>• CNS disease causing long QT interval (i.e. subarachnoid haemorrhage)</li> <li>• Idiopathic apical hypertrophy (a rare form of hypertrophic cardiomyopathy)</li> <li>• Psychostimulant drug use (i.e. cocaine)</li> <li>• Right Ventricular Hypertrophy and Left Ventricular Hypertrophy with "strain" (T-wave inversion in leads aVL, V4-6)</li> </ul> |

Several studies have also identified an increased frequency of ventricular arrhythmias in patients who experience silent attacks. Hoberg and colleagues observed that in 25% of patients who experienced SMI during exercise stress testing also had repetitive ventricular arrhythmias.<sup>55</sup> These arrhythmias included an abrupt increase in the premature ventricular beat rate, the occurrence of single, couplet and triplet premature ventricular contractions, and a single episode of ventricular flutter (ventricular tachycardia) causing collapse. An association between sudden death and silent ischaemia has also been made. Savage et al. were able to demonstrate marked ST segment depression or elevation indicative of myocardial ischaemia in 9 of 14 patients who experienced sudden cardiac death whilst wearing an ambulatory ECG monitor.<sup>56</sup> Similar conclusions have also been made by several other authors.<sup>57, 58</sup> The frequency of silent myocardial infarction also poses several diagnostic challenges. The Framingham Study highlighted that the incidence of silent myocardial infarctions was 26% in men and 34% in women, and approximately half of these patients

experienced no symptoms whatsoever.<sup>59</sup> This data highlights both the significance of using a comprehensive electrocardiography monitor and the diagnostic value that can be obtained from patients who do not follow a typical anginal symptomatology pattern

### **Nitrates**

The formation of atherosclerotic plaque contained within the endothelium inhibits the natural endothelial-dependent dilatation of smooth muscle during ischemia. The use of nitrates as a primary intervention for reducing myocardial workload and increasing oxygen supply is therefore enhanced in these patients. Glyceryl Trinitrate (GTN) reduces preload, afterload and ventricular wall tension during myocardial ischaemia by relaxing systemic and coronary vascular smooth muscle and promoting oxygen transportation via collateral pathways. Nitrates have been shown to significantly improve left ventricular function and ejection fractions in CAD patients.<sup>60</sup> Schang and Pepine showed that sublingual administration of nitrates administered at hourly intervals to CAD patients with ambulatory ischaemia was effective in reducing the frequency of silent attacks compared with placebo.<sup>40</sup> Several other studies noted a decrease in the frequency of SMI by over 60% in patients that were given transdermal patches of GTN to complement their anti-anginal medications.<sup>61-63</sup>

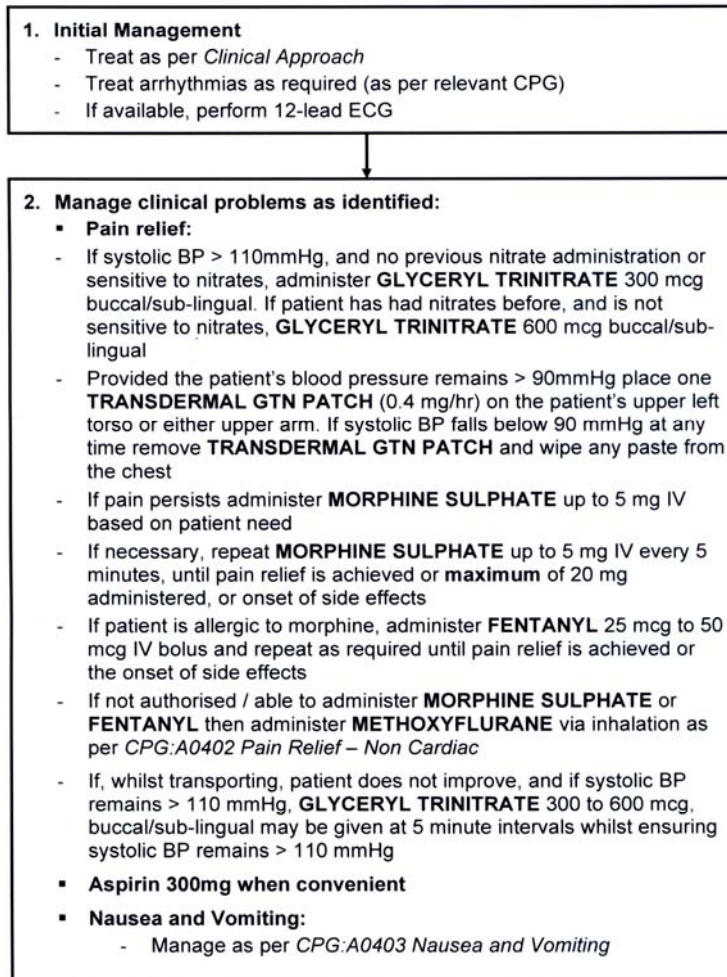
The use of nitrates in the prehospital management of myocardial ischaemia is fundamental to providing effective prehospital emergency care. Regardless of its association with pain, the use of nitrates to increase myocardial oxygen supply and eliminate ischaemia should be the primary indication for administering nitrates – and not on the presence of pain. Prehospital care providers should focus on a multi-factorial assessment of the patient, looking in particular for anginal-equivalent symptoms suggestive of underlying myocardial ischaemia, rather than the quality or severity of pain described.

Unfortunately, the concept of SMI is poorly reported in much of prehospital literature including prehospital clinical practice guidelines/protocols.<sup>64</sup> Figure 3 shows the prehospital clinical practice guideline for the management of adult acute coronary syndromes in Victoria. Immediately, the focus on managing acute coronary syndromes is principally based on the course of pain. Rather than attributing to its anti-ischaemic properties, the use of GTN has been used in complement of analgesics such as morphine sulphate, fentanyl citrate and methoxyflurane. This approach neglects the clinical dilemma of myocardial ischaemia in the absence of angina pectoris and limits the use of nitrates and its anti-ischaemic properties to patients whose clinical presentation involves angina pectoris.

Figure 3:

Management of Acute Coronary Syndromes; Rural Ambulance Victoria & Metropolitan Ambulance Service CPGs<sup>65</sup> (Reproduced with permission of Rural Ambulance Victoria, Copyright Rural Ambulance Victoria)

|                                |   |                          |             |
|--------------------------------|---|--------------------------|-------------|
| Metropolitan Ambulance Service |   | Rural Ambulance Victoria |             |
| Clinical Practice Guideline    | <b>ACUTE CORONARY SYNDROMES (ADULT)</b> |                          | CPG:A0401   |
| Version 1 - 200906             |   |                          | Page 1 of 4 |



### Thromboxane A<sub>2</sub> Active Agents

The efficacy of anti-thrombotics such as aspirin is due to its irreversible inhibition of the cyclooxygenase pathway in platelets, blocking the formation of thromboxane A<sub>2</sub> active agents and preventing coronary thrombosis by impeding platelet aggregation.<sup>66</sup> At varying doses, aspirin is able to decrease both the frequency of silent ischaemic attacks, and their duration.<sup>67</sup> Nyman and colleagues revealed that an aspirin dose of 75mg taken daily by SMI patients reduced episodes of myocardial infarction and death to 4% than those treated with placebo (24%) by 3 months follow-up. Other studies have concluded significant results at varying doses.<sup>66-72</sup> The use of aspirin has also shown to reduce fatal and nonfatal symptomatic myocardial infarctions by 71% during the acute phase, which may potentially facilitate a similar role in patients with silent acute coronary syndromes.<sup>73, 74</sup>

The administration of aspirin in the prehospital setting encounters minimal or no complications, and should represent the gold-standard of prehospital management of suspected myocardial ischaemia.<sup>75, 76</sup> Hooker and co-workers revealed that the most common

reason (33%) for paramedic failure to administer aspirin in patients with angina pectoris was because the pain was not assessed to be of a cardiac nature.<sup>77</sup> A recent audit of patient health care records by the Ambulance Service New South Wales discovered that 18.4% of patients did not receive aspirin from paramedics despite having symptoms consistent with an acute coronary syndrome.<sup>78</sup> Furthermore, almost 35% of paramedics provided no reason for not administering aspirin to these patients, while another 11% of patients did not receive aspirin because they were pain free at the time of ambulance assessment. In light of these results, investigators made several critical recommendations:

1. Replaced the 'chest pain' protocol with 2 new protocols including 'suspected myocardial ischaemia' and 'non-cardiac chest pain' to address the likely atypical presentations of myocardial ischaemia.
2. Eliminated the word 'chest pain' from the aspirin clinical indicator, thus chest pain was no longer a prerequisite for administering aspirin.
3. An aspirin contraindication field was added to the patient health care record to eliminate the need for the clinician to explicitly state the reason for withholding Aspirin.<sup>78</sup>

It should therefore be made clear that the clinical diagnosis of myocardial ischaemia and infarction requires at least a 12 lead interpretation, but ideally angiography and a measure of serum cardiac enzymes. Limiting the diagnosis of myocardial ischaemia to 'typical' and subjective patient presentations in the absence of these resources highlights poor conceptual understanding by the clinician with well documented data to support its limitations.<sup>76, 79-81</sup>

### **Prehospital Thrombolysis in Silent Acute Myocardial Infarctions**

Is ST segment elevation alone, in the absence of angina pectoris and cardiac enzyme tests, enough to clinically diagnose silent acute myocardial infarction and thus facilitate prehospital thrombolysis? The Joint Royal Colleges Ambulance Liaison Committee (JRCALC) would argue against the administration of prehospital thrombolysis in an atypical clinical presentation of an acute myocardial infarction. In contrast, a study by Castle and colleagues showed that the proportion of patients receiving thrombolysis in hospital only meets the JRCALC guidelines in 14.2% of cases.<sup>82</sup> With the majority of these patients excluded because of hypo/hypertension (50%), almost 15% of patients were excluded because of discrepancies in the classification of 'typical' myocardial infarction symptoms, and furthermore over 10% exclusion rates attributed to inconsistencies with questions 2-5, all associated with the characteristics of pain (Table 4).<sup>82</sup>

Table 4: JRCALC checklist for prehospital thrombolysis<sup>82</sup>

| <b>Number</b> | <b>Question</b>   |
|---------------|---|
| 1             | Can you confirm patient is 75 years of age or less?   |
| 2             | Can you confirm that the patient has had symptoms characteristic of a coronary heart attack (i.e. continuous pain typical of an acute MI for 15 minutes or more)?   |
| 3             | Can you confirm that the pain started less than 6 hours ago?  |
| 4             | Can you confirm that the pain had a gradual onset (over minutes) and was not abrupt?  |
| 5             | Can you confirm that breathing does not influence the severity of the pain?   |
| 6             | Can you confirm that the heart rate is between 50 and 140?  |
| 7             | 7) Can you confirm that the systolic blood pressure is more than 80 mmHg and less than 160 mmHg?  |
| 8             | Can you confirm that the ECG shows ST elevation of 2 mm or more in at least 2 standard leads or at least 2 adjacent pre-cordial leads, not including V1?  |
| 9             | Can you confirm that the QRS width is 0.12 seconds or less? And there is no bundle branch block?  |
| 10            | Can you confirm that there is no AV block greater than 1st degree (if necessary, after treatment with atropine)?  |
| 11            | Can you confirm that the patient is not likely to be pregnant, nor has delivered within the last 2 weeks?   |
| 12            | Can you confirm that the patient has not had an active peptic ulcer within the last 6 months?   |
| 13            | Can you confirm that the patient has not had a stroke of any sort within the last 12 months and no permanent disability from previous strokes?  |
| 14            | Can you confirm that the patient has no diagnosed bleeding tendency, has had no recent blood loss, and is not taking warfarin   |
| 15            | Can you confirm that the patient has not had any surgical operations, tooth extractions, significant trauma, or head injury within the last 4 weeks?  |
| 16            | Can you confirm that the patient has not been treated recently for any other serious head or brain condition?   |
| 17            | Can you confirm that the patient is not being treated for liver failure, renal failure, or any systemic illness?  |
| 18            | If streptokinase is your drug of choice, can you confirm that it has not been given previously?   |
| 19            | Can you confirm that the patient has not had chest compressions for resuscitation for a period longer than 5 minutes?   |
| 20            | Can you confirm that the patient is coherent and able to understand that a clot dissolving drug will be used?   |
| 21            | Can you confirm that the patient has been made aware of the risks associated with thrombolytic therapy and that the patient has given consent for the administration of a thrombolytic agent as part of their care? |

Eagle and colleagues have argued that as many as 30% of patients eligible for reperfusion therapy do not receive it because their myocardial event presents with atypical characteristics, i.e. the absence of chest pain, with ST segment elevation in two or more continuous chest leads.<sup>83</sup> While the importance of myocardial necrotic biomarkers is enhanced with these atypical presentations, it should not limit or delay the reperfusion decisions.<sup>84</sup> In addition,

effective implementation of a reperfusion strategy involves a short-window of opportunity, in which time the basis of evidence used to identify myocardial infarction is from the 12 lead ECG analysis alone.<sup>84</sup>

The evidence available suggests that prehospital thrombolysis is as safe as in-hospital administration, regardless of differences in qualification and experience of the health practitioner.<sup>85</sup> Furthermore the administration of prehospital thrombolysis has been shown to exhibit the same proportion of adverse outcomes when compared with in-hospital administration.<sup>86</sup> It is obvious that while this remains a controversial topic for both advocates and critics of prehospital thrombolysis, further research is needed to investigate the incidence of adverse outcomes in patients who are provided with reperfusion therapy in the absence of typical signs and symptoms of myocardial infarction. These results will provide a better understanding of the benefit-harm relationship associated with the administration of prehospital and in-hospital thrombolysis.

### **Limitations**

This review of the literature is potentially limited due to the use of only one medical literature electronic database, which may have resulted in some relevant articles being missed. The omission of non-English articles may have also resulted in portion of literature being excluded.

### **Conclusion**

The prehospital clinical diagnosis of myocardial ischaemia in the absence of pain can be confronting and is often met with several diagnostic and logistical limitations. These limitations include the lack of appropriate diagnostic technology/equipment available to the prehospital care provider. The role of prehospital care providers is limited in many ambulance services such as Victoria, with the use of anti-ischaemic and reperfusion pharmacology reserved for only 'classic' clinical presentations of acute coronary syndromes. While there undoubtedly exists some debate in the administration of thrombolytics to atypical presentations of myocardial infarctions, the use of anti-ischaemic and anti-platelet medications have proven safe and effective in the absence of contraindications. Therefore it would be a recommendation that prehospital care providers appropriately recognise the need to manage these presentations by encompassing all acute coronary syndromes under the single banner and not just those presenting with typical angina pectoris. The prehospital diagnosis of SMI is one that incorporates the patient's physiological assessment as well as their medical history, to develop a suspicion or indication of underlying myocardial ischaemia. In which case, the corrective treatment is identical to patients with angina pectoris.

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