

CHAPTER 2

Literature review

2.1 INTRODUCTION

This chapter discusses the literature review undertaken for the study. Burns and Grove (2001:107) describe the literature review as a critical step in the research process. The researcher obtained literature relevant to AMI, thrombolytic therapy and the outcome of this treatment from MEDLINE (Medical Literature Online), and CINAHL (Cumulative Index to Nursing and Allied Health Literature), the University of South Africa Library, the Tawam Hospital, Tawam Faculty of Medicine and Tawam Institute of Nursing and various recognised websites were accessed via the Internet.

Polit et al (2001:43) state that reviewing literature "enables the researcher to identify what aspects of the topic have been undertaken, the magnitude of the problem being studied, how it is being managed globally, pertinent aspects still to be researched and the theory relevant to the topic".

The purpose of the literature review was to examine the existing information on and knowledge of AMI and thrombolytic therapy. The researcher used various key words related to the topic in the search, such as acute myocardial infarction, door to needle time, delays affecting patients prior to treatment, outcomes, and steps taken to reduce mortality and morbidity related to AMI. The review also prevented possible duplication and provided direction and guidelines for the development of an effective instrument (questionnaire) related to the topic.

2.2 ACUTE MYOCARDIAL INFARCTION

Crawford (2003:57) describes AMI as a "fatal condition caused by a thrombus formation leading to an occlusion of coronary arteries". The author adds that the onset is sudden with crushing retrosternal chest pain, shortness of breath and profuse sweating. The myocardial perfusion is dangerously compromised leading to an imbalance in the between oxygen demand and supply thus reducing the function of the heart.

Davies (2000:362) states that an infarction large enough can cause ventricular compromise and impairment of the left ventricular systolic and diastolic function, with a decrease in stroke volume and a rise in the ventricular filling pressures, leading to hypotension and pulmonary congestion.

According to Oh (1997:43), hypotension impairs the coronary perfusion pressures and exacerbates the ischemia and the autonomic disturbances occurring within the first hour of onset of symptoms are bradycardia and hypotension due to vasodilatation, leading to possible circulatory collapse especially in a large inferior infarction. Casey et al (1998:45) report that when the infarction causes the coronary blood flow to fall below a certain critical level required to maintain myocardial cell viability, cardiac function is dangerously compromised. Rawles et al (1998:576) indicate that the impact on the cardiovascular system is life-threatening, requiring immediate and urgent management.

Myocardial necrosis can occur as soon as fifteen minutes after coronary occlusion with complete necrosis within 4-6 hours and with each passing second, necrosis of the myocardium takes place leading to cardiac compromise and sometimes fatal outcomes (Alpert 2003:378; White & Van de Werf 1998:1646; Marsoo, Griffin & Topol 2000:14). Rawles et al (1998:576) maintain that health care providers should therefore act with the same speed and urgency as that of a patient with a cardiac arrest in critical care and emergency areas in the first hour, which Topol (2003:111) refers to as the "golden hour".

Time is a crucial factor for the coronary patency and reperfusion of the myocardium and with each passing moment the chance of survival diminishes, leading to cardiac compromise with sometimes fatal outcomes (Comeau-Luis, Corbett, Wittlake, Jutzy & Huiskes 1999:246; Marsoo et al 2000:14). Dowdy, Wagner, Birnbaum, Clemmensen, Maynard, Menown, Sejersen, Young and Johansson (2004:390); Berton et al (2001:766), and Ritzman et al (2000:657) found prehospital delays present in the majority of cases.

The mortality and morbidity rates are alarming, considering recent advances in thrombolysis for AMI and delays in treating the eligible patient for thrombolytic therapy must be reduced (NHAAP 1995:58). In addition, the NHAAP (1995:58) calls for health care providers to aim for a door to needle time of <30 minutes in order to reduce delays after arrival at the hospital. Prehospital

delays have already occurred when most patients arrive at accident and emergency units and therefore the urgency to thrombolise within 30 minutes after arrival (NHAAP 1994:311). Most patients suffering for MI, delay seeking assistance and inadvertently contribute to poor outcomes (Dowdy et al 2004:390).

In order to illustrate the physiology of the heart and the implications of a thrombus formation within the coronary vessel to the myocardial cells, the researcher will briefly describe the major blood vessels, the normal cardiac cycle and the electrical conduction of the heart before to illustrate the physiology of the heart and the implications of a thrombus formation within the coronary vessel to the myocardial cells proceeding to discuss AMI.

2.3 MAJOR BLOOD VESSELS AND ELECTROCARDIOGRAPH (ECG) RECORDING

In the following section, the reader is given an orientation to the major blood vessels of the heart, the cardiac cycle and the electrical activity of the heart for clarity of terms and positions mentioned in this study. Illustrations that depict the various concepts are also given.

2.3.1 Major blood vessels

The blood vessels perfusing the heart are the right and left coronary arteries providing nutrients and oxygen to the myocardial cells. The right coronary artery further divides into the posterior-descending artery and supplies blood to the right ventricle and the posterior portion of right ventricle. The left main coronary artery divides into the circumflex artery and the left anterior descending artery and supplies blood to the left and anterior ventricle. Change in the blood flow to the myocardium can adversely affect the function of the heart with fatal consequences (Rhoades & Pflanzer 1996:560). Figure 2.1 is a graphic illustration of the major blood vessels.

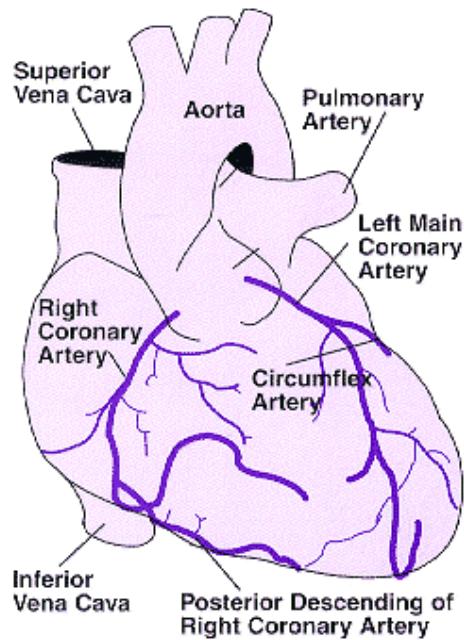


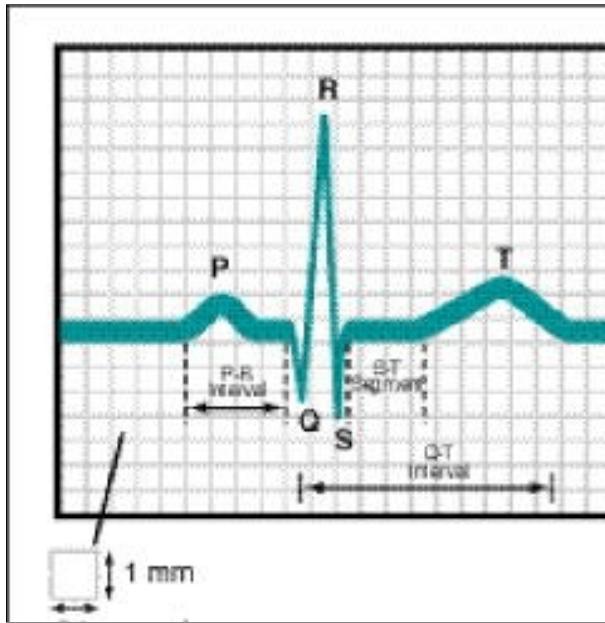
Figure 2.1

Major blood vessels

Source: Rhoades and Pflanzer (1996:558)

2.3.2 The cardiac cycle

A cardiac cycle is represented by the P wave, the QRS complex, T wave, and the baseline that follows until another P wave appears and this is repeated continuously. Physiologically, a cardiac cycle represents atrial systole (atrial contraction), followed by ventricular systole (ventricular contraction) and the resting phase that follows until another cycle begins. Atrial depolarisation (and contraction) is represented by the P wave and the ventricular depolarize action (and contraction) by the QRS complex (Rhoades & Pflanzer 1996:557). Figure 2.2 depicts an ECG recording.



*Figure 2.2
Normal ECG recording (PQRS)*

Source: Dubin (1996:36)

2.3.3 The electrical activity

The electrical activity of the heart is recorded as an electrocardiograph (ECG). It can also be read on a rhythm strip (see figure 2.2), which is a simple display of the heart rate and rhythm. The sinoatrial node is the dominant pacemaker responsible for initiating the stimulus in the atria, causing them to contract. This contraction forces the blood from the atria into the ventricles and is recorded as the P wave on the ECG. The impulses from the SA node are then transmitted via the atrio-ventricular node to the Bundle of His and the Left and Right Bundle Branches. The ventricular conduction system originate in the Bundle of His, which penetrate the AV valves, then reaching the interventricular septum, divides into the Left and Right Bundle Branches. These bundles are rapidly conducting Purkinje fibres causing depolarisation through them. This action causes ventricular contraction resulting in the QRS complex. Following the QRS complex is the horizontal baseline known as the ST segment, followed soon after by the T wave. This ST segment is one of the most important items of the ECG recording for the diagnosis of AMI. The electrical activity of

the heart depends on a well perfused heart with good oxygenation. The ECG is a useful and dependable diagnostic tool used in the diagnosis of cardiac abnormalities in emergency situations. In MI, it is valuable in the diagnosis of ST elevation MI (STEMI) (Dubin 1996:29-36; Rhoades & Pflanzer 1996:559).

2.4 PATHOPHYSIOLOGY OF THE HEART

Atherosclerosis is responsible for most myocardial infarctions as it narrows the lumen of the artery thereby reducing blood flow in the artery, resulting in a reduced oxygen delivery to myocardium (Davies 2000:364). The plaque formation, also termed atheromatous plaques, in the vessels is composed of thrombi that sometimes break away and cause the coronary occlusion. The platelets are soon activated and begin to aggregate and adhere to the thrombus thereby increasing the size of the thrombus further eventually occluding the vessel reducing blood flow to myocardium to a dangerously compromised state (Thelan, Urden, Lough & Stacy 1998:490). When the blood flow to the myocardium falls below a certain critical level to maintain myocardial cell viability, infarction is said to have occurred, with myocardial cell necrosis occurring within fifteen minutes after occlusion of blood flow through the artery; thus causing an imbalance between the oxygen demand and supply (Alpert 2003:378; Crawford 2003:58). The cardiac function is thereafter dangerously compromised due to the damage and is characterised by a decreased cardiac output, low blood pressure and tachycardia or bradycardia (Davies 2000:362). The autonomic disturbances occurring within the first hour of the onset of symptoms are bradycardia and hypotension due to vasodilatation, leading to possible circulatory collapse especially in a large inferior infarction. The pain that follows is sudden, crushing and retrosternal, leaving the patient breathless and if this pain persists, it is referred to as "myocardium infarcting" (Julian, Conway & McLenahan 1998:125).

An infarction large enough can cause ventricular compromise and impairment of the left ventricular systolic and diastolic function, with a decrease in stroke volume and a rise in the ventricular filling pressures, leading to hypotension and pulmonary congestion (Davies 2000:361). Hypotension impairs the coronary perfusion pressures and exacerbates the ischemia (Oh 1997:43). Figure 2.3 is a graphic illustration of MI injury, ischemia and infarction.

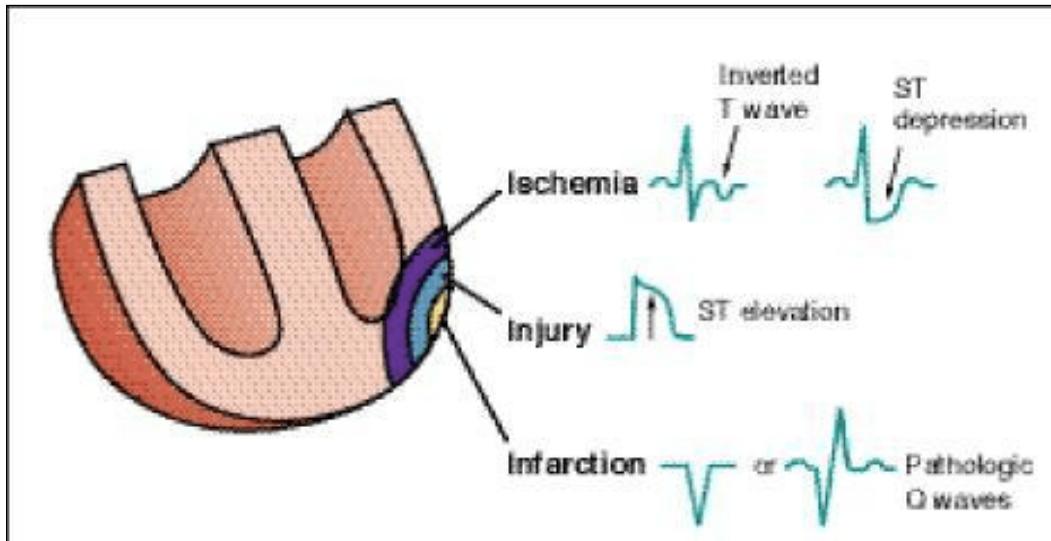


Figure 2.3
Acute Myocardial Infarction: Injury, ischemia and infarction

Source: Rhoades and Pflanzer (1996:558)

In figure 2.3, the ST elevation in the ECG recording is highly indicative and diagnostic of AMI (Dubin 1996:249). The height of the elevation indicates the acuteness of the condition, which may either be slightly or extremely elevated. Injury indicates the acuteness of the infarction. It is the earliest sign that an AMI has occurred (Rhoades & Pflanzer 1996:558)

Ischemia is indicative of decreased blood supply from the coronary artery. This appears as an inverted T wave on the ECG. The presence of Q waves is pathological, indicating necrosis of cardiac muscle and infarction, occurring much later as a result of the muscle death (Dubin 1996:249).

2.5 CLINICAL MANIFESTATIONS

In their study, Kline-Rogers, Martin and Smith (1999:25) found that although most patients, 20,00% of whom were hypertensive and diabetics, had had chest discomfort prior to AMI, there were still 20,00% or more who had the MI as the first manifestation. Quinn and Thompson (1995:209) emphasise that "chest pain - rule out MI" is a diagnostic dilemma occurring in emergency

departments of hospitals *and the staff must nevertheless give the patient the benefit of the doubt by either confirming the diagnosis or ruling it out with speed.

According to Custer (2002:3), a physical assessment may reveal a distressed patient, with a normal blood pressure and heart rate, but the pulse rate may vary from bradycardia to a tachycardia. The ECG recording will display ST elevation and may also have Q waves and new Left Bundle Branch Block. Many patients present with pain in the throat and jaw, the dental area, and shoulder and back radiating down both arms and into the intrascapular area. It is important to remember that not all patients will present with the typical signs. Lauer (2000:3) states that profuse sweating, nausea, pallor, dyspnoea and anxiety often accompany the pain, which is often excruciating, as well as a feeling of impending doom. The pain may begin in the epigastrium, mimicking gastric conditions and leading to a misdiagnosis. In general, patients with chest pain tend to be still but those with AMI can be restless and because of the nature of the pain may even place a hand over the sternum, termed "Levine's sign" (Crawford 2003:59). With more severe infarction and extensive myocardial injury, signs of heart failure and even shock may be apparent and cardiovascular compromise may become apparent, leading to cardiogenic shock and other structural complications if treatment is not initiated immediately after the onset of the symptoms (Clochesy, Cardin, Brew & Rudy 1996:49; Oh 1997:40).

Cardiogenic shock, acute ventricular septal rupture, ventricular free wall rupture and papillary muscle rupture are serious complications arising from AMI.

- **Cardiogenic shock**

Crawford (2003:78) defines cardiogenic shock as a clinical syndrome occurring secondary to inadequate cardiac output as a result of severe left ventricular dysfunction and adds that this condition can be fatal, characterised by peripheral hypo-perfusion and hypotension refractory to volume replacement. The systolic blood pressure may be from 80 mmHg or 90 mmHg if the patient is on inotropic support, leading to a reduced circulating volume, poor oxygen supply and inadequate tissue perfusion. Approximately 5.00 to 10.00% of patients develop cardiogenic shock and the mortality rate is extremely high (80.00%) in the medically treated patient. Although a significant decline is evident in the mortality rates associated with coronary artery disease, the

mortality rates related to cardiogenic shock in AMI is very high in the medically treated patient. The occurrence of lactic acidosis in some patients is a serious metabolic consequence of anaerobic metabolism from inadequate oxygen delivery to sustain aerobic metabolism.

According to Crawford (2003:89), cardiogenic shock may manifest as one or more of the following:

- Diminished peripheral pulses, cyanosis and cool extremities are related to a decrease in peripheral perfusion.
 - The mental status may be altered due to hypoxia.
 - Chest examination reveals rales (abnormal breath sounds in pulmonary oedema) due to pulmonary oedema in some patients with right ventricular failure and tachypnoea (increased respiration rate).
 - The blood pressure is affected due to the low cardiac output and circulating volume cannot compensate as the condition progresses. The systolic pressure may be less than 80 mmHg or unrecordable in some cases with increasing heart rates. Oliguria may be present (less than 30 ml per hour) due to the reduced circulating blood volume.
- **Acute ventricular septal rupture**

According to Crawford (2003:79), rupture of the ventricular septum occurs in about 3,00% of AMI patients and contributes to 5,00% of deaths. The rupture occurs around three to seven days post-MI and results in hypotension, severe heart failure and prominent heart murmur. Prompt surgical intervention is recommended to reduce mortality.

□ **Ventricular free wall rupture**

Rupture of the free wall of the left ventricle occurs in 0,80 to 6,20% within 24 hours and up to three to five days post-MI and accounts for 15,00% of peri-infarction deaths, characterised by angina, pleuritic or cardiac pain, syncope, severe hypotension, restlessness and sudden death (Antman et al 2004b:679). Almost 50,00% of the ruptures take place in the first five days and 90,00% in the first two weeks. Nakatani, Sato, Kinjo, Mizuno, Hishida, Hirayama, Mishima, Ito, Matsumura and Hori (2003:785) found that the incidence of free wall rupture has decreased to a certain extent in the fibrinolytic era with occurrence in the first 48 hours post-infarction. However, Antman et al

(2004b:679) maintain that it is not fibrinolytic therapy that reduces the risk but rather primary transcutaneous coronary angioplasty that seems to reduce the risk. Crawford (2003:80) states that prompt intervention includes echocardiography with pericardiocentesis, intra-aortic balloon pump placement, urgent cardiac catheterisation and anticipated cardiac surgery. This is a condition that occurs suddenly and too often the signs of rupture are not present until acute haemodynamic compensation has occurred.

- **Papillary muscle rupture**

Antman et al (2004b:679) report the occurrence in about 1,00% of myocardial patients within 24 hours up to five days, with abrupt onset of shortness of breath and pulmonary hypotension. The prognosis is poor in these conditions, unless urgent surgical interventions can be instituted (Crawford 2003:80).

2.6 DIAGNOSIS OF ACUTE MYOCARDIAL INFARCTION

Certain criteria have been identified and guidelines formulated for the diagnosis and management of AMI (Antman et al 2004a:678; Crawford 2003:60; Oh 1997:54; Selim & Hmoudah 2002:526). The criteria include chest pain and biochemical markers of cardiac damage, among others.

- **Chest pain**

Crawford (2003:57) describes the chest pain as intense, crushing, substernal and on the left side usually radiating to the left arm with a sense of impending doom.

- **Electrocardiogram (ECG)**

The ECG remains the mainstay in the diagnosis of AMI, especially with characteristic changes related to the PQRST wave. This is considered the "gold standard" for the diagnosis of AMI according to Antman et al (2004a:679) (see figure 2.4). It is also referred to as "something that contributes to making diagnosis simpler for cardiologists in diagnosing MI (Antman et al 2004a:679).

The following PQRST changes take place:

- ST segment abnormalities are related to muscle injury.
- The classical feature of ST elevation of 1mm or more in two or more contiguous leads is considered diagnostic of MI, occurring very early after symptom onset (see figure 2.3).
- The acuteness of the infarction can be seen in the ST segment elevation with evidence of ST segment depression.
- Deep Q waves indicative of necrosis of cardiac muscle take hours to develop after symptom onset, indicating infarction.
- The presence of new Left bundle branch block and T wave inversion, indicating ischemia. This is due to a defect in the conduction system (Crawford 2003:60; Julian et al 1998:125).

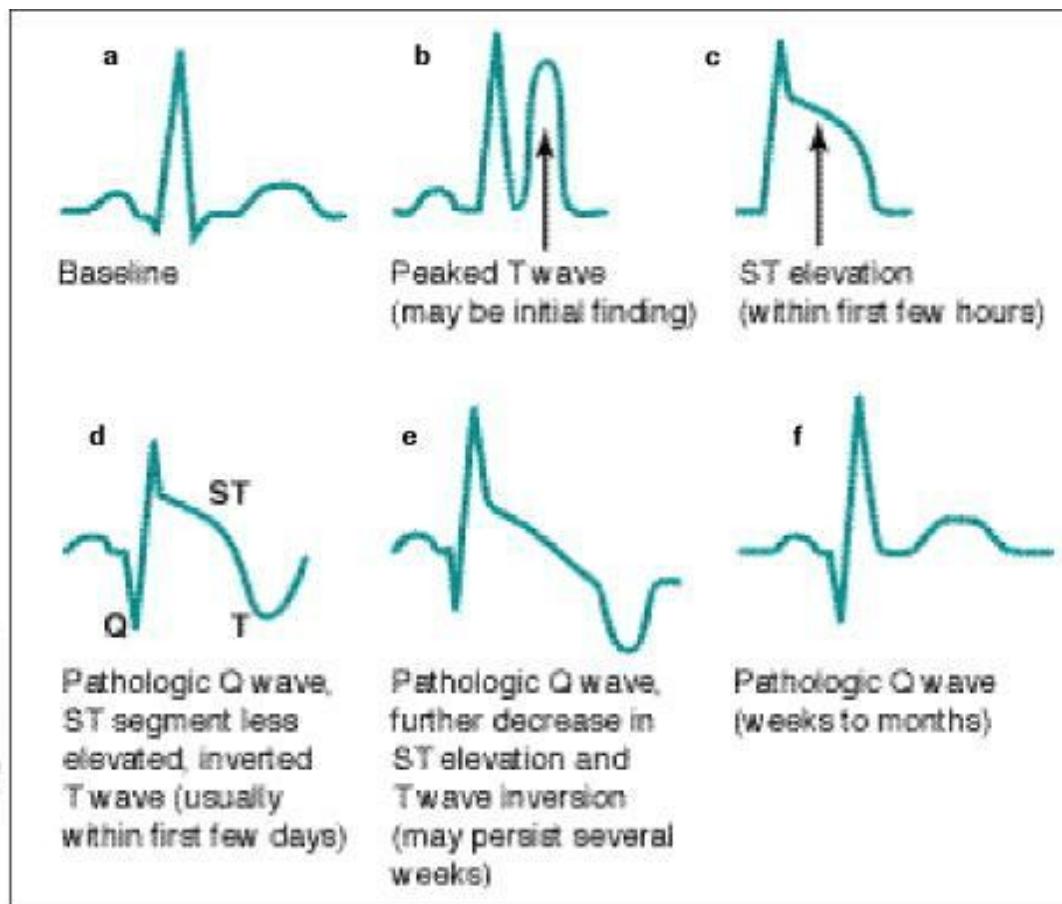


Figure 2.4
Diagnostic ECG: AMI

Source: Rhoades and Pflanzer (1996:558)

Keys:

- a Baseline: Normal ECG
- b ST elevation immediately after onset
- c ST elevation within few hours after onset
- d Q waves later after symptom onset
- e Q Pathologic Q, further decrease in ST elevation and T inversion
- f Pathologic Q (weeks to months later)

- **Biochemical markers of cardiac damage**

The biochemical markers of cardiac damage are evident in myocardial proteins, creatinine kinase muscle brain (CK-MB), myoglobin (MYO) and cardiac Troponin 1 (cTn1 and cTnT). These are described below.

- **The myocardial proteins**

Antman et al (2004a:679-680) and others such as Jenkins (1994:74), maintain that it is also necessary to seek other supporting evidence, such as biochemical markers or cardiac enzymes, when the patient is first examined in the emergency room. Various proteins and enzymes enable the heart to function and are released in the presence of damage to the muscle by lack of oxygen and nutrients. They can be detected in the blood and are considered classical indicators of MI. However, these laboratory examinations should not impede the implementation of reperfusion therapy as the biochemical markers are not required at the time of thrombolysis.

- **Creatinine kinase muscle brain (CK-MB)**

The typical rising and falling pattern of CK-MB, characteristic of heart muscle is indicative of myocardial injury. It rises from four to twelve hours after injury and peaks at eighteen to twenty-four hours, returning to baseline in no more than 48 hours (Antman et al 2004a:679).

- **Myoglobin (MYO)**

Myoglobin is detected in the blood within one to two hours after MI. Myoglobin can be found exclusively in cardiac and skeletal muscles and can be elevated in patients receiving intramuscular injections and cardioversion, so myoglobin is not a reliable indicator of muscle damage, but allows early detection. However, it peaks between four and twelve hours and can be detected within four hours of onset (Jenkins 1994:74).

- Cardiac Troponin 1(cTn1 and cTnT)

The markers cTn1 and cTnT are not usually found in healthy individuals and therefore are reliable in diagnosis of myocardial infarction. Troponin occurs only in the myocardium and even at low levels is an indicator of myocardial tissue destruction. It is detected about three to twelve hours after damage to myocardium. It is more reliable than CK-MB as they are more cardiac specific, and cardiac Troponin T is now regarded as "evidence-based medicine" and the "gold standard" as a biochemical marker indicating its reliability in the definition and diagnosis of AMI (Jenkins 1994:73; Lam 1999:4). Compared to other biochemical markers, Troponin T and 1 are considered sufficient in diagnosis within 24 hours after onset of symptoms (Custer 2002 :2).

As routine laboratory examinations are part of AMI management, the decision to thrombolyse is not based on the results, therefore there should be no delay while awaiting laboratory reports, however, they are important for use by cardiologists, in post-thrombolysis and recovery phase (Antman et al 2004a:679).

Table 2.1 depicts the types of infarction which occur in the coronary vessels and highlights the changes that take place in the ECG recording.

Table 2.1 ECG changes and vessels in infarction

VESSEL	TYPE OF INFARCTION	ECG CHANGES
Left Anterior descending Artery (LAD)	Anterior Infarction	ST Elevation I, AVL, V1-V4, Q wave V1-4
Circumflex coronary	Lateral	Q wave 1 & AVL
Right and Left Coronary Artery	Inferior Infarction	St Elevation VI-4, QwaveII,III,AVF.
Left Anterior Descending	Antero-Septal	St Elevation V1 & V4, Q wave

Adapted from Dubin (1996:261-265), Julian et al (1998:126) and Marsoo et al (2000:6).

Doctors and nurses working with these patients must be able to quickly identify these changes to enable them to act in order to prevent further cardiac damage and mortality.

2.7 PAIN EXPERIENCE

Julian et al (1998:125) use "myocardium infarcting" to refer to the ongoing pain associated with AMI and emphasise the need to relieve the pain and ischemia to prevent further ongoing muscle damage. Crawford (2003:57) states that the chest pain is typically severe and constant, retrosternal and spreading across the chest and associated with breathlessness, accompanied with sweating and cold, clammy skin.

Ross (2001:2) describes a study conducted by Dr Sheffield at a Florida University which revealed that ethnicity appears to play a major role in the reaction and reporting of pain. The author adds that Sheffield states that people have differing beliefs regarding whether it is "good or bad" to experience pain and that people have various coping mechanisms before seeking assistance. This factor may be used to explain to an extent the delays for patients seeking assistance after pain onset.

Showalter (2004:1) states that American society is changing from all white to multicoloured; from European-American to African- and Asian-American; from exclusively Judeo-Christian to encompassing Islam, Hinduism and Buddhism among other religious traditions and stress the significance of cultural competency in a culturally diverse community. According to Showalter (2004 :1), pain experience can be divided into stoic and emotive categories: stoic patients "grin and bear it" and emotive patients verbalise the expressions of pain. Expressive patients come mainly from Hispanic, Middle Eastern and Mediterranean backgrounds and stoics from North European and Asian backgrounds. Showalter goes on to say that nursing, medical and hospital cultures influence pain assessment, decision-making and care and an understanding of the impact of cultures on the experience and expression of pain is crucial to effective patient management.

Leninger (Toomy & Alligood 2002:506) declares that, from her experience with over fourteen different cultures that each person differs in every aspect and encourages cultural sensitivity in treating patients in diverse cultural environments.

Carr (1997:53) supports this statement. In this country the society is composed of multi-nationals, with varying attitudes, traditional health practices and beliefs that can affect their response to pain.

2.8 MYOCARDIAL INFARCTION MANAGEMENT

The goal of treatment for MI is to preserve the myocardium, control the pain, administer pharmacological therapy and manage the complications arising from the condition. AMI must be accorded the same urgency as a cardiac arrest (Rawles et al 1998:576).

2.8.1 Preservation of the myocardium

Mortality is correlated with the time lapse between the onset of symptoms and reperfusion of the myocardium, whether by means of thrombolytic therapy or surgical intervention. Keller and Feit (1998b:646) indicate that the first six to twelve hours after the onset of pain is the most crucial period for myocardial salvage and the chances of successful reperfusion diminish with time. It is imperative to treat this condition urgently in restoring the ante- grade blood flow through the infarct-related artery as delayed efforts may be futile or dangerous (Nakatani et al 2003:785; Topol 2003:112). Topol and Keriakes (2003:1463) state that, compared with medical treatment alone, early invasive cardiac revascularisation significantly reduces mortality even after six and twelve months. In a study on primary angioplasty in MI in Denmark, Topol and Keriakes (2003:1464) found that patients' data at 30 days after discharge indicates that percutaneous coronary interventions are superior to thrombolytic therapy in terms of survival, despite delays.

According to Spiers (2003a:33), percutaneous coronary intervention has proven to be superior to pharmacological treatment in terms of speed of reperfusion at 60 and 90 minutes, fewer reinfarctions and mortality at 30 days. Clinical trials indicate decreased ischemic strokes, improved left ventricular function, fewer reinfarctions and mortality at 30 days (Casey et al 1998:45; Spiers 2003a:33).

Spiers (2003a:34) states that in the UK, primary angioplasty is considered the "gold standard" because of the excellent outcomes in reperfusion of myocardium, but thrombolytic therapy is now the first line treatment due to financial constraints and lack of personnel and resources. However, problems such as a tendency to bleed, delays in performing the procedure because of a lack of reasonable resources, and high costs have led to angioplasty being abandoned. Spiers (2003a:34) adds that many hospitals lack specialised cardiac facilities so most therapeutic strategies for MI

focus on pharmacological agents for reperfusion together with antiplatelet aggregators and antithrombins.

From the discussion above it is evident that most literature refers to thrombolysis as a cost-effective, readily available and speedy method of reperfusion and timely preservation of myocardium in absence of coronary surgical interventions (Keeley, Boura & Grines 2003:13; Lundergan, Reiner & Ross 2000:456). Unfortunately, however, the researcher has found that at the Al Ain Hospital, many patients do not seek treatment early enough to be eligible for thrombolysis and often die.

2.8.2 Pain control

The management of pain is of paramount importance as ongoing pain is suggestive of ongoing ischemia and poses additional risk to the non-infarcted myocardial tissue (Julian et al 1998:125). Antman et al (2004b:679-680) discuss guidelines to manage pain in ST elevation MI. Morphine, 2 to 4 mg IV with increments of 2 to 8 mg intravenously (IV) repeated at five to fifteen-minute intervals, is the mainstay in pain relief in AMI, relieving pain, decreasing anxiety, restlessness, and autonomic nervous system activity, preload, thereby reducing myocardial oxygen demands. Although morphine is useful the side-effects can also compromise a patient's haemodynamic profile. Bradycardia, respiratory depression, vasodilatation and decreased contractility of myocardium are manifest. Care must be taken when administering the drug therefore titration is advised to ensure patient safety in the use of morphine together with close monitoring of vital signs (Kline-Rogers et al 1999:31).

Nausea and vomiting are common side-effects associated with morphine administration and most doctors prescribe metaclopropamide 10 mg IV to combat this. Sublingual administration of Nitro-glycerin, 0,4 mg every five minutes for a total of three doses initially, to dilate coronary blood vessels and improve circulation, thereby decreasing ischemic pain. As the pain intensity increases, intravenous nitro-glycerin at doses of 5 to 10 micrograms per minute can be commenced and titrated according to the patient's response. Vigilant haemodynamic monitoring of the blood pressure, at least at five to ten-minute intervals, is essential as severe hypotension develops as a result of the vasodilatation. Patients on Tridil often complain of a headache and can

be treated symptomatically with paracetamol 500 mg tablets by mouth.

2.8.3 Pharmacological therapy

Every country has its own pharmacological interventions, however the basic principles stays the same. There are some routine measures, and specific measures such as reperfusion therapy and thrombolytic therapy to be applied as well as action to be taken when dealing with the patient who suffers an AMI. These aspects are *briefly* discussed below.

□ Routine measures

The American College of Cardiology and American Heart Association (ACC/AHA) (1990:664-707) have drawn up guidelines for the early management of AMI patients. Cannon (2002:781), Quinn and Thompson (1995:209), Maxey (1997:229) and Antman et al (2004b:679-680) have drawn up critical pathways, protocols, case maps, and guidelines to assist in the management of AMI patients and patients with ST elevation MI at emergency and accident units.

The doctor's prescription should preferably be in accordance with the ACC/AHA (1990:664) guidelines and, ideally, should be standing orders in all emergency departments and executed immediately and precisely. In some hospitals, for example in South Africa the Entabeni Hospital in Durban and RK Khan, KwaZulu-Natal, guidelines exists which are signed and updated regularly to facilitate the care in the emergency rooms prior to arrival of the cardiologists. This is also the current practice at the Al Ain Hospital, with the written prescription of the emergency physician.

Morphine, Oxygen, Nitro-glycerin, Aspirin (MONA) are the immediate routine treatment administered in most MI cases if there are no contraindications to medical orders.

- Morphine: Is administered as analgesia, reducing myocardial oxygen demands and relieving pain at doses of 2 to 4 mg with increments of 2 to 8 mg intravenously at five to ten-minute intervals.
- Oxygen: Supplemental oxygen is administered to patients with arterial oxygen saturation

less than 90,00%. Approximately 2 to 4 litres of oxygen per minute are given via face mask to assist with oxygenation to maintain oxygen saturation above 90,00%. Continuous pulse oximetry monitoring is essential.

- Nitro-glycerin: Given sublingually 0,4 mg every five minutes up to a total of three doses after which the need to administer intravenous nitro-glycerin for the relief of ongoing ischemic discomfort is assessed. Nitrates improve coronary blood flow, interrupt spasms and decrease oxygen demands by systemic vasodilatation. However, the risk of hypotension is high therefore vigilant monitoring is imperative when administering this agent IV (Casey et al 1998:40; Crawford 2003:71).
- Aspirin: should be chewed by the patient at doses between 162 and 325 mg. Non-enteric coated Aspirin is advised as more rapid buccal absorption occurs than the enteric-coated aspirin formula.

The patient must remain in bed rest with minimal movement. A bedside chest X-ray must be done. The nurse has to act rapidly and remain with the patient at all times, providing constant reassurance and explaining all procedure to alleviate anxiety and fear. The calm attitude of staff working in this area is a positive contribution. Continuous vigilance in monitoring of the level of consciousness, the blood pressure, heart rate and rhythm and respiration is vital to detect early complications (Antman et al 2004b:680). Continuous assessment of the pain must be made with measures to eliminate it as ongoing pain is an indication that the infarction is still present. Each step of the care and management must be meticulously documented.

□ **Reperfusion therapy**

The restoration of the blood flow in the obstructed infarct-related artery after symptom onset is the key determinant of short * and long *term outcomes regardless of the method of reperfusion used (Crawford 2003:71). The use of ancillary therapy, for example, antiplatelet aggregators and antithrombins, is considered helpful in maintaining the patency of reperfused myocardium together with the fibrinolytic agent (Beller 2001:2428).

- An anti-platelet aggregator, for example, Aspirin (Antman et al 2004b:680) at doses of 162 to 325 mgs (chewed by patient), is useful for disruption of the platelet aggregation around a thrombus. The clot formed by the aggregation of the platelets around the thrombus will increase the size of occlusion if left undisrupted. Aspirin is the drug selected for inhibiting platelet surrounding the thrombus and increases fibrinolysis (Crawford 2003:71). Non-enteric-coated aspirin is preferred to enteric-coated aspirin as it increases buccal absorption.
- Ticlid or Ticlopidine 250 mgs may be given orally as a substitute if aspirin is not well tolerated (Antman et al 2004a:679).
- Antithrombins such as unfractionated Heparin and low molecular weight Heparin are used as adjunctive therapy to sustain patency after thrombolysis to prevent re-occlusion of vessels. Heparin 5 000 units is preferred with Reteplase double bolus dosing fibrinolytic agent and heparin 4 000 units for Tenectaplae single bolus dose agent.

After the initial bolus dose of either 4 000 or 5 000 units, the maintenance dose is 1 000 units per hour and titrated accordingly. The profiles of activated partial thromboplastin time and partial prothrombin time are valuable in adjusting doses (Dracup & Cannon 1999:6).

- Although Heparin, given after thrombolytic therapy is highly beneficial in achieving anticoagulation and sustaining the patency, it may cause haemorrhage as it interferes with the formation of thrombus from Prothrombin; therefore the utmost care must be taken with the administration and on going assessment of clotting profile. Low molecular weight heparin Fraxiparine 0,3 mgs and Enoxaparine 0,4 mgs are used in selected cases after heparin infusion has been discontinued (Ryan, Antman, Brooks, Califf, Hillis, Hiratzka, Rapaport, Riegel, Russel, Smith & Weaver 1999:1026).

Crawford (2003:72) states that the use of Glycoprotein 11b 111a receptor antagonist in non-ST elevation MI is increasing with drugs like Aggrastat (Tirofiban), which is given IV at an initial infusion rate of 0.4 micrograms per kilogram per minute (mcg/kg/min) and continued at a maintenance dose of 0.1 mcg/kg/min. Usually bolus dose Heparin is given first then a

maintenance dose of 1000 units per hour infusion. Aggrastat is being successfully used as antiplatelet aggregators. These agents bind to the platelet fibrinogen receptor sites and prevent platelet aggregation and activation.

Abciximab 0.25 mcg/kg IV bolus over ten to sixty minutes is also used as a GP 11b 111a inhibitor. Clopidogrel (Plavix), given as 75 mg daily orally, is a more recent addition to the antiplatelet aggregators. It is currently used in non-ST elevation MI together with aspirin or as an alternative to aspirin. Successful reperfusion and better outcomes have been reported with the use of this agent. It is used when there is a history of allergy and intolerance to aspirin as well as in the treatment of acute coronary syndromes together with aspirin to relieve ischemia. The ACC/AHA (Antman et al 2004a:680) include these agents in their recommendations for acute coronary symptoms and MI.

- **Thrombolytic therapy**

Thrombolytic therapy is generally a safe and effective pharmacological method of treatment reserved for eligible patients with AMI (White & Van de Werf 1998:1632). The primary therapeutic goal in management of acute myocardial infarction is the prompt, rapid, complete and sustained restoration of infarct-related artery blood flow to preserve the myocardium and reduce mortality (Topol 2003:111). This agent lyses (breakdown) clots and restores the blood flow in the infarct-related artery, reperfusing the myocardium and restoring cardiac function. Complications are limited and survival rates improved if the time to treatment is in the first hour after the onset of symptoms for the eligible MI patient (Arntz 2001:91; Morrison, Verbeek, McDonald, Sawadsky & Cook 2000:2686; Quinn & Thompson 1995:208).

The speed of reperfusion is currently faster with the new range of fibrinolytics than the first-generation thrombolytics (Assessment of Safety of New Thrombolytic Regimen-3 (ASSENT 3) Studies 2001:605-613; Heyns & Landless 1998: 107-114; NHAAP 1994:311).

The timeliness of the administration is a major determinant of the outcomes hence the urgency of thrombolytic treatment. Health care providers should be aware of the management of chest pain, and the use protocols and guidelines related to thrombolysis (Comeau-Luis et al 1999:246).

□ Action

Fibrinolytics/thrombolytics are exceptional agents in lysing (breaking down/dissolving) thrombus formed in coronary arteries, restoring the blood flow in the occluded coronary artery and reperfusing the myocardium. They work by converting plasminogen to plasmin, which then breaks down the fibrin strand that holds the thrombus together hence the term "fibrinolytics" (Topol 2003:112; White & Van de Werf 1998:1632). The lay or non-medical term for them is "clot busters". Once perfusion is restored, ancillary therapy is given to prevent coagulation and reocclusion; for example, Heparin infusion to sustain patency in the vessel of the jeopardised myocardium (Antman et al 2004b:682).

2.9 TRIALS AND THROMBOLYTICS

Since the mid-1980s, trials and studies have been conducted on improvement and safety in the delivery of fibrinolytic therapy. Several thrombolytic therapies have been in use and their efficacy in minimising the mortality and morbidity rates has been tested and studied. Consequently thrombolytics have been greatly improved in terms of safety and efficacy. Casey et al (1998:39) point out that trials are still being conducted in pursuit of the perfect thrombolytic agent, which will yield more benefit and reduce the risks in terms of morbidity and mortality.

The following thrombolytics are currently in use: Streptokinase, Alteplase, (t-PA), Tenectapase, Reteplase, Lanotapase, Anistreplase, Purokinase and Staphylokinase. Table 2.2 depicts some of the more popular thrombolytics currently in use and the improvement and progress made in ease of administration and time to deliver the agents (Antman et al 2004b:600).

Table 2.2 Thrombolytic agents currently in use

	ALTEPLASE FRONT-LOADED (t-PA)	RETEPLASE (r-PA)	TENECTAPLASE (TNK-t-Pa)	STREPTOKINASE (STK)
Dose	100 mg	10+10 MU	Weight adjusted : 30 mg for weight less than 60 kg 35 mg for weight 60-69 kg 40 mg for weight 70-79 kg 45 mg for weight 80-89 kg 50 mg for weight 90 kg or more.	1,5 MU IV
Duration	IV bolus 15 mg infusion 50 mg (0,75 mg/kg)over 30 minutes 35 mg over 60 minutes, overall total not exceeding 100 mg	10 MU IV over 2 minutes. > Second bolus dose after 30 minutes - 10 u over 2 minutes.	10-15 seconds	over 30-60 minutes
Rate of reperfusion	Faster than STK	Faster than Alteplase	Faster than Alteplase	Slower than (t-PA) Alteplase
TIMI Grade 3 flow at 90 minutes	Achieved in 70,00-75,00%	Achieved early in 70,00-80,00%	Achieved in 75,00-80%	Achieved in 50,00-70,00%

Adapted from Antman et al (2004a: 680; Armstrong and Collen (2001:10); Casey et al (1998:43) and Kline-Rogers et al (1999:31).

The advancement in the assessment of the safety and efficacy of a new thrombolytic agent (ASSENT-2 1999:722) has contributed to successful outcomes, where Tenectaplate and Reteplase were tested for ease and safety in treatment in and out of hospital. The newer agents, though more costly, provide more benefit in terms of mortality and morbidity rates and a lowered risk of cerebral strokes (Topol 2000:126).

Thrombolytic therapy administration was previously a lengthy procedure, lasting nearly three hours thus contributing to further delay in reperfusion (Friedman et al 1994:723). Streptokinase was first discovered and used in 1958 and a total of twenty-four trials were conducted from 1960 to 1970 to evaluate the efficacy of intravenous Streptokinase (White 1998:494). Reports of cerebral

haemorrhages, strokes and allergies led to the development of (t-PA-Alteplase) tissue plasminogen activator (Topol 2000:122).

The Gruppo Italiano per lo studio della Streptochinasa nell' Infarto Miocardico (GISSI 1986:397) study was the first large-scale trial to demonstrate the effectiveness of thrombolytic therapy in mortality reduction (White 1998:494). The GISSI (GISSI1a 1986:397) trial demonstrated a 51,00% mortality reduction rate if streptokinase was administered within the first hour after the onset of symptoms (White & Van de Werf 1998:1633).

Further controlled trials of streptokinase found a significant and substantial reduction in AMI patient mortality. The second International Study of Infarct Survival (ISIS-2) (1995:349) found thrombolytic therapy, chiefly using streptokinase as the thrombolytic agent, effective in reducing early mortality in patients with MI. The findings indicate that streptokinase indeed improves the five-week survival rate of the patient and can persist for some years although the effects seem greatest among various patients treated most promptly, including the elderly. The ISIS-2 (1995:349) trials also found survival advantages with the use of fibrinolytic therapy and the importance of aspirin in the treatment.

The third ISIS study (ISIS-3 1999:753) compared the benefits and risks of streptokinase, anisoylated plasminogen-streptokinase activator complex and tissue plasminogen activator (Alteplase-t-PA) in suspected cases of AMI. The study found that Alteplase achieves a higher coronary artery patency rate within ninety minutes than the others included in the trial. The use of tissue plasminogen activator demonstrated consistent beneficial effects over streptokinase in terms of coronary perfusion. Moreover, Alteplase as a human protein having no bacteria had fewer episodes of allergies than Streptokinase.

The Global Use of Strategies to Open Occluded Arteries (GUSTO) Angiographic Investigators' (GUSTO-II 1993:1615) MI reperfusion trials found a 15,00% mortality reduction for accelerated t-PA compared to streptokinase. Topol (2000:126) states that this established the mechanism for early patency of the infarct-related artery. Four thrombolytic treatment strategies, including an accelerated regimen of t-PA and STK, were used to demonstrate the superiority of the accelerated t-PA in terms of coronary reperfusion at ninety minutes. This agent is also termed "front-loaded t-

PA", given over ninety minutes, first as a bolus dose of 15 mg then as an infusion of 50 mg over thirty minutes and 35 mg over 60 minutes (not more than 100mg). The study supported the theory that a 'front-loaded' or accelerated regimen of t-PA demonstrates a Thrombolysis in Myocardial Infarction (TIMI) grade 3 flow and is therefore more beneficial to survival than streptokinase and thus useful in improving left ventricular function and reducing mortality rates. These findings are supported by Van de Werf, Topol, Lee, Woodlief, Granger, Armstrong, Barbash, Guerci, Simes, Ross and Califf (1995:1586).

A study by the Fibrinolytic Therapy Trialist (FTT) Collaborative Group (1994:311) found that fibrinolytic therapy does indeed reduce mortality. The aim of this study was to demonstrate the overall benefit of thrombolytic therapy using the overview of nine trials, namely GISSI-1, Intravenous Streptokinase in Acute Myocardial Infarction (ISAM), ISIS-2, ASSET, ISIS-3, Estudio Multicentrico Estreplokinasa Republica de America de Sur (EMERAS) and Late Assessment of Thrombolytic Efficacy (LATE), over time to resolve uncertainties in the use of thrombolytic therapy. The agents included Streptokinase, Anistreplase, Alteplase and Purokinase.

The study found that mortality was reduced even with a time lapse of up to twelve hours and that a wide range of patients especially at risk for cardiac death, many of whom are not thrombolysed for lack of evidence to support the treatment, would benefit. The FTT Group (1994:311) recommended "not allowing uncertainties to obscure the very clear evidence of the overall benefit" of fibrinolitics in patients with ST elevation up to twelve hours from symptom onset and not withholding thrombolytic therapy due to uncertainties as the benefit out weighs the risks attached to the treatment even after twelve hours. However, Rawles (1997:1181) disputes that late thrombolysis can save lives and maintains that AMI must be accorded the same "degree of urgency as that of a cardiac arrest". Rawles (1997: 1181) discovered that mortality rates after five years of patients treated later than twelve hours after symptom onset were high thereby proving the benefit of early thrombolysis. The NHAAP (1995:58) recommends thrombolysis delivery to eligible patients within the first two hours after symptom onset.

Smallling, Bode and Kabfleisch (1995:2725) report the superiority of bolus administration reteplase over alteplase infusion in MI. In 1997, however, the GUSTO III (1997:1118) trials with the new bio-engineered reteplase and alteplase found that, besides the ease of administration, Reteplase was

similar to Alteplase in terms of mortality at thirty days and the incidence of strokes.

In the 1985 the Thrombolysis in Myocardial Infarction (TIMI-1) trial (1985:932) classified blood flow through the infarct-related artery before and after reperfusion. The benefit of fibrinolytic therapy is based on the TIMI-1 grade 3 flow for improved and sustained reperfusion and the aim of all cardiologists is the TIMI-1 grade 3 flow for myocardial reperfusion in sixty to ninety minutes (Topol 2000:123). Table 2.3 depicts the TIMI-1 flow grades.

Table 2.3 Thrombolysis in MI (TIMI-1) flow grade

GRADE	BLOOD FLOW
0	Totally occluded
1	No flow beyond occlusion
2	Flow into thrombus but not beyond (occluded blood flow), sluggish flow
3	Normal brisk flow

Source: TIMI Study Group (1985:932)

Cineangiographic studies were done prior to and after using Streptokinase and Alteplase to assess the blood flow through the artery and classify it according to a grade (see table 2.3). It was found that TIMI grade 3 flow at ninety minutes had a low mortality compared to either grade 0 or 1 flow (Greene 2001:1).

Grade 0 in table 2.3 indicates that the blood flow is occluded, while in grade 1 the blood flows into the thrombus but not beyond, thus indicating the presence of occlusion. Grade 2 demonstrates a sluggish but not normal flow, and finally grade 3 indicates the restoration of the normal brisk flow through the infarct-related artery.

The GUSTO II Angioplasty Investigators (1993b:1615) found that a significant difference in the 30-day mortality rate in the TIMI grade 3 flow and sustained patency after reperfusion is related to improved left ventricular function and improved survival rates at thirty days.

The arrival of the third-generation thrombolytics has added a new dimension to the treatment of AMI because with longer half-life and the ease of bolus dosing, the rates of reperfusion are comparatively faster (Beller 2001:2428; Keller & Feit 1998:543; Tsikouris & Tsikouris 2001:207). This is due to greater fibrin specificity and longer half-life compared to STK (Beller 2001:2428). The quest for the ideal thrombolytic therapy has progressed to the single-dose weight-adjusted Tenectaplate. The ASSENT-2 studies (1999:716) show the ease of administration, safety and efficacy of Tenectaplate as a 10-second single bolus-dose compared to the front-loaded IV infusion Alteplase. The safety and efficacy of this agent has been demonstrated by its greater specificity for fibrin than t-PA, lower plasma clearance resulting in a longer half-life, which allows for single bolus administration and a greater resistance to plasminogen activator inhibitor. The TIMI flow grade 3 patency rates at ninety minutes were 57.00% to 64.00% faster in 30 to 50mg doses with TNK-t-PA than t-PA (front-loaded Alteplase). At sixty minutes, the TIMI grade 3 flow suggests faster reperfusion with Tenectaplate (TNK-t-PA) than Alteplase (t-PA). Furthermore, the calculation and preparation of the dose is also simple and quick as it is adjusted according to the patient's weight, with reduced reports of medication errors. Due to the delays prior to treatment, the speed of administration of this agent is appealing in terms of single-dose administration and faster reperfusion with subsequent myocardial salvage providing the answer to prehospital thrombolysis (Arntz 2001:91; ASSENT-2 1999:716; Keller & Feit 1998b:646).

Agents with faster reperfusion rates are particularly appealing for use in AMI, especially in view of the anticipated prehospital delays, prior to arrival at the hospital (Cannon, Gibson, McCabe, Adjey, Schweiger, Braunwald, Frey, Guiglano, Steinhart, Van de Werf & Weaver 1998:2805). In addition, the use of Tenectaplate is being widely studied as a promising new single bolus dose fibrinolytic, the ideal method of prehospital thrombolysis (Arntz 2001:91; Cannon et al 1998:2805). The TIMI grade 3 flow is achieved at ninety minutes with a single bolus dose of 40 mg (Pedley, Bisset, Connolly, Goodman, Golding, Pringle, McNeill & Jones 2003:22). Keeling et al (2003:27) and Welsh et al (2003:1) maintain that although there may be risks, the benefits outweigh them. The calculation of the dose is also simple, quick and weight adjusted with the administration at between five to ten seconds and fewer medication errors (ASSENT-2 1999:716).

Another deletion variant of Alteplase (t-PA) is Ianotoplase (n-PA), which is slightly less fibrin specific than t-PA, but more potent in terms of reduced plasma clearance and the preserved

fibrinolytic activity. Comparisons between these two demonstrate that 46,00% patency is achieved with t-PA and 50,00% with n-PA though the rate of bleeds and strokes remain the same.

Reteplase Angiographic Phase 11 International Dose Finding (RAPID-1) trial in 1995 revealed the superiority of Reteplase (r-PA) compared to Alteplase in achieving more rapid, complete, and sustained patency at 90 minutes through angiographic studies. Bode, Runge and Smalling (1996:891) found complete reperfusion at ninety minutes occurred with a 10u bolus dose Reteplase, thirty minutes apart, than compared to the Alteplase given over 90 minutes infusion. Armstrong and Collen (2001:5) found that the same Reteplase dose yielded higher 90-minute reperfusion rates (59,00% versus 45,00%) than front-loaded Alteplase.

Reteplase is currently the selected agent offered to patients with AMI at Al Ain Hospital and administered as a double-bolus dose of 10 units, thirty minutes apart. The first dose is sometimes commenced in the accident and emergency unit with safe transfer of the patient to the cardiac or intensive care units for administration of the second dose, which can be withdrawn in case of a bleed. However Tenectaplate and Alteplase are also administered on occasion.

According to Keller and Feit (1998a:541), the newer generation thrombolytics generally have the ease of administration with single bolus dosing and longer half-life, but have not yet demonstrated any increase in safety or efficiency than other thrombolytics used in the past.

2.10 THE IMPORTANCE OF TIME TO THROMBOLYSE

The NHAAP (1994:311) has provided guidelines to assist health care providers reach the goal of reducing the time to thrombolysis and published information to assist bystanders, families, friends and co-workers to react and manage a heart attack to increase awareness and reduce prehospital delays. The publication, *Rapid identification and treatment of the AMI patient for the health care provider*, provides relevant guidelines and protocols to facilitate the patient's care after arrival at the emergency room (NHAAP 1993:2). Prompt reaction can reduce delays and improve the chance of survival, thus reducing mortality and morbidity rates. This is only be possible if significant persons involved in the care of AMI patients appreciate their roles and are aware of the outcome and the need for speed in expediting care for patients with Acute Myocardial Infarction. Those preparing

files and emergency admission papers must be trained to work with speed in order to contribute to reducing delay at the triage area. Attempts must be made to increase the awareness of the ambulance drivers who respond to calls from peripheral and outlying areas, through education and training, as they do not have a medical background recommends the NHAAP (2002:777). Many are without transport and have to rely on the speed and efficiency of a good driver to get them safely and timeously to the hospital. The ideal transfer time of the patient should be sixty to ninety minutes from time of call to time of transfer to the hospital (NHAAP1995:58; ACC/AHA 1990:664). Rawles (1997:1181) maintains that the AMI patient should be treated the same degree of urgency as one who had sustained a cardiac arrest.

Health personnel have no control over prehospital delays; however delays after arrival must be minimised to approximately thirty minutes "door to needle time" (NHAAP 1993:1).

The FTT (1994:311) found that maximal benefit was achieved if treatment was initiated in the first hour after onset of symptoms (65 lives saved/1 000 treated patients) as compared to the 50,00% reduction of benefit after the first hour (37 lives saved/1 000 treated). Welsh et al (2003:5) report a sevenfold reduced mortality rate among patients treated before seventy minutes compared to patients treated later. Welsh et al (2003:5) go on to say that the benefit of early thrombolysis is clearly evident and the thirty-day mortality rate was: >70 minutes – 8, 70% and <70 minutes – 1, 20%. According to Welsh et al (2003:2), even though data has been recognised and reported for over a decade now, the time to thrombolysis in major ST elevation MI trials remains stalled at approximately three hours after symptom onset.

Letovsky and Allen (1996:509) maintain that early thrombolysis also relieves pain promptly, improves myocardial perfusion and cardiac function with a reduction in mortality and morbidity rates.

EMERAS (1993:762), LATE (1993:759), ISIS-2 (1986:349), GISSI-1 (1986:397) and GISSI-2 (1990:65) demonstrate that maximum benefit is derived from the thrombolytics within the first two hours after onset of symptoms. Norris (2000:728), Lincoff and Topol (1993:1361) and Topol (2000:122) describe the first hour as the "golden hour" for this vulnerable patient. When the myocardium is deprived of blood, oxygen and a nutrient, the passing of time critically compromises

the condition ASSENT-3 (2001:613); GISSI-1 (1986:397); GUSTO 1993a:673; Pedley et al 2003:327; Ryan et al 1999:1016). In the Netherlands, Boersma, Maas, Deckers and Simoons (1996:771) also report the benefit of early thrombolysis in the first two hours after symptom onset. Although some doctors offer patients arriving later than six to twelve hours thrombolytic therapy, the results are less dramatic than a patient treated within the first hour after symptom onset and many patients thrombolysed later die soon after receiving treatment. A number of patients also experience cardiogenic shock, cardiac arrest and arrhythmias, sometimes with poor outcomes. The cause of death is mainly due to cardiogenic shock, which is clinically poor cardiac output and evidence of tissue hypoxia that is not improved with correcting the intravascular volume. Cardiogenic shock occurs in about 50.00 to 80.00% of persons; 50.00% have it before arriving at hospital and others develop it after twenty-four to forty-eight hours (Danchin et al 2003:9). Thrombolytic therapy more than two hours after symptoms onset reduces mortality but with less dramatic benefits. Improvement of left ventricular function as measured by the global ejection fraction is less obvious, despite the reduction in mortality. Although myocardial salvage may still be possible in patients who present after the second hour, delays with thrombolytic therapy are still unacceptable. The relationship of outcome from symptom onset to time of reperfusion is significant and survival is improved through several mechanisms. Alpert (2003:377) states that the data on left ventricular function and mortality indicate that myocardial necrosis occurs at a rapid pace and that thrombolysis within one to two hours of symptoms onset produces myocardial salvage (time-dependent) that affects both left ventricular function and survival. Alpert (2003:377) goes on to say that time is crucial in re-establishing blood flow to the myocardial cells as they necrose in a matter of 15 minutes in the absence of blood and oxygen supply. Futterman, Correa and Lemberg (1996:165) support this, stating that animal studies conducted in 1995 found that the necrosis of myocardial cells after coronary occlusion occurs rapidly if untreated soon after onset of symptoms. White and Van De Werf (1998:1646) state that complete necrosis of cells of the myocardium in an ischemic zone requires approximately four to six hours. Table 2.4 represents the relationship between time and cell necrosis.

Table 2.4 Relationship between time and percentage of cell necrosis

TIME	% CELLS NECROSED
40 minutes	38,00%
3 hours	57,00%
6 hours	71,00%
24 hours	85,00%

Source: White and Van de Werf (1998:1646)

Table 2.4 indicates the time taken for the myocardial cells to necrose. Within forty minutes, almost 38,00% of myocardial cell necrosis takes place; within six hours, 71,00% of cells necrose; within twenty-four hours, 85,00% of cells necrose, with cardiac compromise and fatalities seen in patients arriving late for treatment. Thrombolytic therapy after this point is considered futile in the treatment of AMI (White & Van de Werf 1998:1646)

Nakatani et al (2003:785) conducted studies that revealed that early administration of thrombolytic therapy indeed reduces the incidence of free wall rupture, an effect that is partly responsible for improved survival, however late administration of thrombolytics increases the risk of free wall rupture. Evidence in completed studies reveals the presence of myocardial cell wall rupture related to the late administration of thrombolytic therapy.

Quinn and Thompson (1995:208) state that if there is the slightest possibility of improving the chances of survival, many doctors still offer the patient thrombolytics after twelve hours despite the risks to the patient.

In their study of time to thrombolysis in thirty hospitals in England, Scotland, Wales and Northern Ireland, McCabe and West (1998:81) found that the time to administer thrombolytic therapy was slow overall. In view of this finding, they recommended that hospitals audit the management of the AMI patient for thrombolysis because the timeliness of thrombolytic therapy does indeed improve the chance of survival and the delays should therefore be reduced. Comeau-Luis et al (1999:246) also support the timely delivery of thrombolytic therapy to the eligible patient.

Letovsky and Allen (1996:509) state that despite the emphasis on reducing delays in treatment, time, remains one of the greatest challenges in the treatment of AMI. Prehospital delays are present prior to arrival at hospitals and many eligible patients are also inappropriately denied the life-saving benefit of thrombolytic therapy (Letovsky & Allen 1996:511; Wald 1998:329). Withholding this effective treatment from the eligible patient can contribute to increasing mortality and morbidity rates. Emergency hospital staff should familiarise themselves with the available thrombolytics, dosages, management and care to deal effectively with complications arising from thrombolytic therapy (Letovsky & Allen 1996: 509; Wald 1998: 329).

Health care providers invest time and effort in the resuscitation of these patients, but it is sometimes futile as cardiogenic shock, arrest and death ensue. The loss of life is tragic and always brings a feeling of hopelessness and powerlessness and can be prevented if the patient is treated soon after the onset of symptoms. Considering the work done in this area and recent advances in many countries to improve the care and management of AMI patients, the rates of mortality and morbidity are dismal and of concern to cardiologists, researchers and health care providers the world over (Boersma et al 1996:771).

2.10.1 Managing complications arising from thrombolytic therapy

Although thrombolytic therapy is of great benefit, there are associated complications that threaten the life of the AMI patient further, such as bleeding, of which cerebral haemorrhage is the most fatal.

□ Haemorrhagic disorders: cerebral and non-cerebral

By its nature, thrombolytic therapy is a risk, due to the anticoagulation action, setting the stage for haemorrhage, so prior to administration adequate assessment must be made according to the eligibility criteria and the contraindication guidelines (Antman et al 2004b:680; Crawford 2003:72). Cerebral haemorrhage and strokes are the most fatal and account for a large proportion of post-thrombolysis fatalities. Haemorrhagic stroke is the most difficult to manage. The vigilant monitoring of vital signs, neurological assessment, level of consciousness, motor and sensory function is important. If intracranial bleeding commences, the thrombolytic must be discontinued and a

computed tomography scan done to assess the bleed. Protamine Sulfate 10 mg IV is administered to reverse the effects of the thrombolytic agent. In addition, Cryoprecipitate, fresh frozen plasma and platelets must be transfused to increase the fibrinogen levels (Antman et al 2004a:683).

ISIS-2 (1988:349) found that although two out of 1 000 patients will suffer strokes after thrombolysis; doctors should thrombolyse patients after careful assessment, because the other 998 patients will benefit from the intervention. The quest for the ideal pharmacological reperfusion agent continues in an effort to improve the outcomes of thrombolytic therapy for the patient with MI (Antman et al 2004a:683; Welsh et al 2003:1).

Beller (2001:2428), Crawford (2003:58), Davis, Evan, Strickland, Shaw and Wagner (2001:35), Topol (2003:116) and White and Van de Werf (1998:1646) state that bleeding can also occur in any other organ besides the brain and emphasise following the set guidelines. Meticulous care must be taken in intravenous (IV) cannulation, blood extraction, and furthermore arterial and central venous punctures must be minimised after thrombolysis as it predisposes the patient to bleeding tendencies. It is advisable to insert two intravenous access sizes 18G or 20G, prior to commencement of treatment. Baseline assessment of the coagulation, haematological and cardiac profile is mandatory prior to commencement. Vigilance in monitoring all vital signs, including the urine for haematuria, is important. Later the patient must be instructed to refrain from shaving and briskly brushing teeth for a while (Antman et al 2004a:680).

A cardiologist or physician should preferably directly supervise the administration. The area used in the emergency room must be adequately equipped with a defibrillator, ventilators, other resuscitative equipment and emergency drugs. If bleeding commences, an attempt should be made to control it with local pressure. If there is significant bleeding, thrombolysis and heparin infusion (if applicable) should be immediately discontinued. The doctor must reassess the coagulation profile, get blood grouping and reserve cross-match in readiness to transfuse (Massel & Klein 1999:6).

- **Reperfusion arrhythmia**

This period can be especially dangerous for the patient as reperfusion arrhythmia occurs soon after

the blood flow is re-established and the myocardium is reperfused. The patient is susceptible to dangerous ventricular tachycardia and fibrillation and, in some cases, cardiac arrest, and therefore needs closer monitoring during this vulnerable post-thrombolysis period. Casey et al (1998:47) state that emergency equipment and medications should be maintained in readiness, and experienced staff used in caring for this patient. In addition, staffing must be adequate to carry out the emergency care the patient may need, such as defibrillation.

Anaphylaxis

This situation is rare and applies to a small percent of people, and affects the use of Streptokinase administration, due to its bacterial origin. It is advisable to stop the infusion in cases of suspected allergies and commence anaphylactic treatment (Massel & Klein 1999:11). Careful monitoring of vital signs is essential to avoid potential cardiac arrest (Oh 1997:55; Rivello & Hoekstra 1998:2365).

2.11 BARRIERS TO TIMELY REPERFUSION

Crawford (2003:72) states that there many barriers to timely reperfusion, especially prehospital and in-hospital delays, and can include eligibility for thrombolysis as well.

2.11.1 Prehospital delays

Patient-related delays, due mainly to illiteracy, ignorance, denial, transport difficulty and fear, are a significant issue and impact on the "door to needle time" (Ritzman et al 2000:657). Prehospital delays are a major impediment to timely and successful therapy and contribute greatly to the mortality rates hence the urgency of reducing delays after arrival at hospital to increase the chances of survival (Bertoni et al 2001:766; Dowdy et al 2004:390; Pedley et al 2003:22; Reilly, Dracup & Dattolo 1994:300; Ritzman et al 2000:657). This led to community awareness and outreach programmes for public education (Keeling et al 2003:27; NHAAP 1994:311-329). In Europe and the USA such programmes were successful, but due to the high cost were not sustained.

The National Heart, Blood and Lung Institute (NHAAP 1993:4) set up numerous educational programs and one of them was the National Heart Attack Alert Program launched in 1991. National Heart Attack Alert Program together with the National, Heart, Blood and Lung Institute are active committees in the promotion of the general management protocols of acute myocardial infarction patient. This is achieved through public awareness programmes, website information, educational campaigns, translating new research findings and dissemination of latest research information to public and health care providers on issues related to MI so that it can be quickly integrated into health care practice and individual behaviours (Welsh et al 2003:3). The goals are to reduce the morbidity and mortality, including myocardial sudden death, through rapid identification and treatment both outside and inside the hospital (NHAAP 1994:311).

2.11.2 In-hospital delays

Since hospital personnel have no control over patients' symptom to door time their goal must be to aim for a minimum door to needle time (Davis et al 2001:35; Welsh et al 2003:2). The NHAAP (1994:311) recommends reducing the "door to needle time" to thirty minutes from the patient's arrival at the door to treatment time and a "call to needle time" of ninety minutes. According to Antman et al (2004a:678), the goals in the management of MI include reducing the time to thrombolysis in the race for "chain of survival" (chain of survival is the chain which is formed from the door, the doctor, diagnosis and drug administration) (NHAAP 1994:311).

According to NHAAP (1994:311), delays ranging from the "door through to the needle time" have been identified at numerous emergency departments. In a survey at a hospital in Toronto, Letovsky and Allen (1996:509) found that 59,00% of deaths were hospital-related and could have been avoided if personnel were more committed to rapid action for the treatment of AMI patients in emergency departments. Early identification and thrombolysis leads to prompt coronary reperfusion and indeed improves outcomes for the AMI patient. The maximum benefit, however, is achieved within the first one to six hours after symptom onset in terms of myocardial salvage with subsequent reduced mortality and morbidity rates (Welsh et al 2003:2). The treatment of AMI has evolved since the 1970s from the silent treatment of bed rest, observation and managing complications to aggressive treatment during and after the event (White & Van De Werf 1998:1646). Although the medical and technological revolution in the three decades has

dramatically improved clinical outcomes for patients with ST elevation MI (STEMI), residual mortality and morbidity remain major health concerns (Topol 2003:114). The critical role of delays and optimal sustained patency as modulators of successful reperfusion has been demonstrated in numerous trials. For example, in a North Carolina emergency department Davis et al (2001:35) found delays in treating the elderly and women with AMI, made relevant recommendations and provided appropriate education and training in an effort to change habits, practice and attitudes. In their study on reducing delays in thrombolytic therapy in the emergency department in Australia, Senior and Patel (1998:99) make recommendations to improve current strategies and adopted other simple strategies to reduce delays.

Delays can occur throughout patient care from the "door to needle time", specifically from the door, the data-collection time, the decision-making time and the administration of thrombolytic therapy time all impact eventually on the time to thrombolysis (NHAAP 1994:311). The present study examines the specific areas after the patient arrives at the hospital for potential delays.

2.11.2.1 Delays at the door (triage time)

After arrival at the hospital, delays may occur at the reception area and the staff responsible for preparing the files must be trained to act with speed to reduce delays. A lack of assessment skills and knowledge of MI and "time to treat" on the part of the triage nurse, other emergencies occurring simultaneously, constrained resources and other factors can contribute to delays at the time of arrival. The nurse in the triage can contribute effectively in reducing the door to needle time by astute assessment and unique observational skills and an "aggressive triage" is advised in an effort to reduce the time to thrombolysis (Dowdy et al 2004:390). In overcrowded emergency areas it is possible to overlook (miss) such a patient. Efforts must be directed at formulating clinical or critical pathways and protocols for management of the AMI patient soon after arrival. A "fast track" and triage response is essential in managing the acute myocardial infarction patient effectively (Wald 1998:329). "Chest-pain, rule-out MI" must be actively practised to reduce delays occurring in waiting rooms or triage areas (Quinn & Thompson 1995:208).

2.11.2.2 Data-collection time

Getting sufficient information quickly is the aim of data collection and involves the assessment of the clinical manifestations, taking the patient's history and the ECG recording and assisting in deciding on the eligibility criteria (Antman et al 2004a:678). Acquiring and obtaining the ECG in the emergency department is at the centre of the therapeutic decision as it indicates that ST segment elevation is present. In addition, the ECG must be collected and screened by an emergency physician within 10 minutes of arrival at hospital (Davis et al 2001:36). The nurse who collects the data must be familiar with ECG recording and interpretation in order to alert the doctor whose ultimate responsibility is to analyse the ECG (Antman et al 2004a:678). Leaving the ECG waiting for the doctor to arrive to interpret the recording is unacceptable in the management of AMI (Quinn & Thompson 1995:208).

Antman et al (2004a:678) state that a patient suspected of having AMI must be shifted to the resuscitation room and connected to the cardiac monitor with the doctor in attendance. All necessary laboratory profiles must be collected and two size 18 or 20 gauge intravenous accesses inserted. This measure is undertaken to protect the patient from trauma and potential haemorrhage from re-cannulation after thrombolysis has commenced. Meticulous monitoring and documentation of vital signs is mandatory with constant reporting to the doctor. Doctors and cardiologists practise the ACC/AHA guidelines as far as possible in the emergency room of the Al Ain hospital. Cannon (2002:781) recommends clinical pathways in the triaging of patients and Maxey (1997:229) recommends case maps to speed up the management of AMI patients.

2.11.2.3 Decision to thrombolyse time

In several countries such as the USA, UK and others as well as at the Al Ain Hospital the decision to thrombolyse is a medical one (Edhouse, Saker, Wardrobe & Morris 1999:325). The patient is first seen by the emergency doctors and referred to either the cardiologists or the physicians to make the decision to thrombolyse. The policies are in accordance with international standards and the institution's policy regulations. There are more complications and deaths from MI than from the side-effects of thrombolytic therapy; therefore doctors who see the patient first should administer the drug if the risks are minimal (Letovsky & Allen 1996:509; Quinn & Thompson 1995:213).

In a study at a teaching hospital in the UK, Wald (1998:329) found that some doctors were reluctant to administer thrombolytic therapy based on intuitive fears of causing harm to the patient. Wald (1998:329) also states that for a condition with such high mortality rates, thrombolytic therapy has been underused and should be used for eligible patients with MI. The benefits from this treatment outweigh the risks, which must be managed symptomatically, but it is crucial to reopen the infarct-related artery within two hours after symptom onset.

In Australia, using a coronary care trained nurse exclusively to assess, refer and treat patients with chest pain according to doctor's orders, Kucia, Taylor and Horowitz (2001:186) found that nurse assessments not only reduced the time for treatment, but also the time consumed by unnecessary admissions and delays encountered by doctors in assessments. Of the patients presenting with chest pain, 50.00% were discharged directly from the accident and emergency unit. Considering the admission cost and the scarce resources in available critical care beds, the saving was "tremendous" (in Kucia et al's terms) in terms of bed occupancy. However, the cost of the supernumerary nurse was challenging to the hospital budget and not sustained.

In a study in one of the developed countries, Lloyd, Roberts, Bashir, Kamalvand, Mumby and Cooke (2000:462) found that cardiac care nurse-led thrombolysis was successful and safe, and reduced the call to needle time. In the UK, Spiers (2003a:33) found that a "thrombolysis nurse" (meaning a nurse trained specifically to treat patients suffering from an MI), makes a significant contribution to reducing delays in the treatment of patients.

In the UK, Scotland and Wales, emergency services personnel (paramedics) are trained in coronary care to deliver prehospital thrombolytic therapy safely at the site of call thereby reducing the time to thrombolyse as they are situated at various distances from hospitals (Pedley et al 2003:22). With the high technology in telemetry ECG, it is possible to get assistance from doctors in hospitals to rural areas. However, the true positive results in interpretation of the ECG showed that EMS staff working in the accident and emergency field scored 49.00% and 88.00% for the cardiologists.

In the rural areas of Scotland, Rawles et al (1998:576) found that thrombolysis in the call to needle time is improving the survival of MI patients as more general practitioners are commencing

thrombolytic therapy prior to referral to hospitals, thus reducing delays.

2.11.2.4 Eligibility criteria

For the treatment of MI, the patient must fall within the eligibility criteria bracket, according to international standards, (Antman et al 2004a:679) with either two or more of the following present:- Continuing chest pain, presenting for treatment at hospital within twelve hours of symptom onset and evidence of changes on a 12-lead ECG (Antman et al 2004a:679).

- Chest pain lasting more than thirty minutes**

The pain associated with AMI usually lasts for more than thirty minutes and is continuous and, in most cases, the dose of sublingual nitrates is insufficient to relieve the pain. Patients are advised to take up to three doses of 5 mg Isordil (nitrates) before seeking medical assistance (Antman et al 2004a: 680).

- Time of presentation**

Thrombolysis is successful in patients arriving at hospital for treatment earlier than twelve hours as myocardial tissue necrosis occurs thereafter and thrombolytic therapy is ineffective in reperfusing the myocardium. Nakatani et al (2003:785) emphasise that it is dangerous, in fact, as it can cause free wall rupture. The ideal time to thrombolyse is within the first two hours after the onset of the symptoms although some doctors give patients the benefit of treatment even up to twenty-four hours after symptom onset (Bates 1997:8).

- ECG changes**

ST elevation indicates recent injury that can be resolved, providing thrombolytics are administered timelyously. ST elevation 1 mm in size and present in 2 Limb leads. ST elevation must be 1 to 2 mm in size and present in at least two chest leads. New Left Bundle Branch Block indicating conduction defect (Antman et al 2004a:679) as depicted in Figure 2.4.

- Contraindications for thrombolytic therapy

Wald (1998:329) states that the contraindications vary but are based mainly on the possibility of haemorrhagic conditions. For the purposes of this study, the ACC/AHA contraindications (Antman et al 2004:683) are used. The contraindications are categorised according to risk of bleeding and consist of absolute and relative contraindication (see table 2.5). Relative contraindications indicate that the patient can be given a chance with thrombolysis although the risk is great; but the benefit of the agent outweighs the risk (Antman et al 2004a:683; Keller & Feit 1998a:548). Absolute contraindications indicate that the patient must not receive the agent due to fatal risks to the present condition.

Although the danger associated with thrombolytic therapy must not be ignored, its contribution in reducing mortality and morbidity in MI should be appreciated. The risk of ischemic strokes is high and non-cerebral bleeds do occur occasionally but the benefit must be recognised and utilised for patient survival. Table 2.5 depicts the absolute and relative contraindications for thrombolysis.

Table 2.5 Contraindications for thrombolytic therapy

ABSOLUTE	RELATIVE CONTRAINDICATIONS
Any prior intracranial haemorrhage	Suspected aortic dissection
Known structural cerebral vascular lesion	Significant closed head or facial injury within 3 months of trauma
Known malignant intracranial neoplasm	Active bleed or bleeding diathesis
Ischemic stroke within three months EXCEPT acute ischemic stroke in three hours	History of chronic poorly controlled hypertension Severe hypertension Systolic BP>180 Diastolic BP>110 History of prior ischemic stroke greater than 3 months, dementia or known intracranial pathology not covered in contraindications Traumatic prolonged (>10 minutes) CPR or major surgery Recent internal bleed (within 2-4 weeks) Non-compressible vascular punctures For Streptokinase/Anistreplase: Prior exposure (more than 5 days ago) or prior allergy Pregnancy Active peptic ulcer Current use of oral coagulant: the higher the INR, the higher the risk of bleeding

Source: Antman et al (2004a:683)

According to Spiers (2003b:221), ineligibility for thrombolytic therapy does not mean ineligibility for reperfusion. Percutaneous transluminal coronary angioplasty is a surgical intervention reserved for patients who are ineligible for thrombolysis and is also available as a primary intervention in many affluent countries. Primary coronary interventions are the first choice available to patients who can afford the cost through health insurance and medical aid schemes (Spiers 2003b:221). Topol (2003:111-116) recommends the establishment of specialised centres to make provision for such interventions because the success rate in TIMI grade 3 flow is more rapid and sustained compared to thrombolytic therapy. Coronary artery by-pass graft through surgery (CABG), although more costly, is performed and gaining popularity as a means to restore perfusion to triple vessel diseases. Success rates are high as cardiothoracic surgery is becoming increasingly efficient. Some patients are reperfused using primary angioplasty instead of thrombolytic therapy as their eligibility for thrombolytic therapy diminishes with time.

2.11.2.5 Drug administration time

The time taken to administer the agent is vital as the longer it takes to infuse the agent, the longer the reperfusion time. The current third generation fibrinolytics, like Tenectaplate and Reteplase, have ease of administration because of the bolus dosing.

This will restore reperfusion faster thereby reducing the period of ischemia (ASSENT-2 1999:716; ASSENT-3 2001:605). In addition Tenectaplate is weight adjusted and easy to calculate and Reteplase is a simple 10 unit dose given thirty minutes apart, avoiding the lengthy administration procedures of the past.

The benefit from this treatment outweighs the risks, which must managed symptomatically, but it is of paramount importance to reopen the infarct- related artery within two hours after symptom onset (Wald 1998:329). Antman et al (2004a:677) state that the successful treatment of patients with AMI requires absolute collaboration and intense cooperation between cardiology, emergency doctors, pharmacy, radiology, laboratory and all nursing and medical personnel concerned. Timely and accurate management of patients with AMI is required to reduce delays in the accident and emergency unit. This, in turn, impacts on the outcome of the patients' response to thrombolytic therapy.

2.12 MANAGEMENT AND CARE OF PATIENTS

The management and care of patients receiving thrombolytic therapy must be directed towards obtaining successful outcomes for those with AMI. This means that, in addition to reducing the time to thrombolysis the patient, the care provided needs to be swift, precise and accurate. Therefore the health care providers at each stage must be knowledgeable and skilled in the specific management of this vulnerable patient. The emphasis is on knowledge and skill.

Knowledge is acquired through careful systemic research, clinical practice experience and literature. A mixture of skill, knowledge, critical thinking, speed and commitment to quality care are desired in the staff taking care of patients in desperate need of life-saving measures. The staff must also possess the necessary knowledge, skill and expertise to treat the patient, and have insight into complications after AMI and thrombolytic therapy. Continuous education and training is vital to keep all EMS and critical care workers up to date, with the aim of improving and sustaining excellent care of the AMI patients (Beller 2001:2428). The personnel involved must act with speed and precision in triaging the patient to obtain immediate care. Having even the slightest suspicion that a patient has an infarction will contribute to reducing the door to needle time. A quick, brief history can verify the information before the patient is appropriately triaged. An ECG recording is obtained in all suspected cases. "Chest pain, rule out MI" is recommended to assist doctors to either confirm or rule out the diagnosis of AMI (Quinn & Thompson 1995:208).

The outcomes for the patient will depend on

- the time treatment is given
- the speed of administration of drug
- reperfusion achieved
- sustained patency
- complications arising

Recognition of the importance of time to thrombolysis in ST elevation MI can help to reduce delays and improve outcomes for the patients (Welsh et al 2003:3). In addition, precision, speed and

efficiency are required to reduce delays in treatment and vigilance in monitoring is imperative. Quinn and Thompson (1995:208) point out that medical personnel, including the cardiologist, should be present throughout the therapy until the patient settles and the condition is considered stable. The cardiologist or physician must accompany the patient to the critical care areas for admission in anticipation of reperfusion arrhythmia, cardiac arrest, haemorrhage and allergies which could occur as complications.

Antman et al (2004a:715) state that in order to deliver appropriate and timely care to the patient, adequately trained staff and a sufficient number of staff must be deployed to assist deliver priority care, once diagnosed is confirmed and thrombolysis commenced. It is essential to foster collaborative teamwork to reduce mortality and morbidity and the vulnerability of the patient demands absolute dedicated monitoring to reduce the associated risks. The ratio of nursing and medical personnel should increase from 1:1 to 1:4. This is a short-term "time investment" but a "long-term" survival chance for the patient and efforts must be directed to affording the patient the optimum opportunity (Hourigan, Mountain, Langton, Jacobs, Roger, Jelinek & Thompson 2000:157).

Expert monitoring, assessment, detection and treatment of abnormalities are required together with a calm controlled attitude. Speed is essential in the delivery of treatment to the patient in terms of myocardial salvage (Kline-Rogers et al 1999:31). The knowledge and skill of medical and nursing personnel is necessary in executing life-saving interventions in the prescription and administering of all emergency drugs (Quinn & Thompson 1995:208). Being familiar with what is expected in caring for the patient with AMI will facilitate an efficient and speedy delivery of care. Having a good background of possible complications related to AMI will positively impact in the patient's outcome of the thrombolysis. Doctors and nurses alike must be committed, responsible and accountable for their part in this global endeavour (Kline-Rogers et al 1999:33; Quinn & Thompson 1995:208). Rawles (1997:1181) emphasises that MI must be accorded the same degree of urgency as that of a cardiac arrest.

2.13 AREA OF THROMBOLYSIS

The question of where to thrombolyse is taking on new dimensions in terms of reducing time to thrombolyse. The critical and coronary care areas are no longer the areas reserved exclusively for thrombolysis as trauma and emergency units are now taking the responsibility to thrombolyse patients in their unit or admit them directly to coronary care units in an endeavour to reduce the time to thrombolyse (Hourigan et al 2000:157). Delays are present prior to arrival to hospitals therefore the emergency departments are urged to take responsibility and thrombolyse patients immediately after arrival i.e. 30 minutes from "door to needle time" (NHAAP 1994:311). Rapid thrombolysis can contribute to a reduced door to needle time and an improved outcome. In Al Ain hospital, thrombolysis is carried out safely and efficiently in the accident unit, when beds are not available in the critical areas. Irrespective of where the patient will be thrombolysed, emergency and resuscitation equipment for resuscitation must be provided and available (Bennet 1989: 261). Defibrillator, mechanical ventilators and equipment for external pacing, Cardio-version and means to intubate the patient must be available together with all the emergency drugs. Ideally, experienced personnel with expert knowledge and skills must be involved in the resuscitation of this vulnerable patient. Staff must be adequately trained so that they are effective as a team in this crucial life-saving situation. They must be familiar with the necessary protocols to provide the patient with the safest care possible within the constraints of the hospital. The thrombolytic agent must be readily available within the department as it can be time consuming to obtain the drug from the pharmacy at the time of administration. Emergency doctors should be responsible for and familiar with all aspects of thrombolytic therapy, and cooperate with policies and protocols that will facilitate the rapid and safe standard administration of thrombolytic therapy in emergency departments to reduce mortality and morbidity rates (Edhouse et al 1999:325; Letovsky & Allen 1996:509). The move to thrombolyse in prehospital settings is also gaining momentum, especially where the travel time to hospital impacts negatively on the outcomes, in countries like the United Kingdom, Ireland, Denmark and Scotland, among others (Dowdy et al 2004:390-394; Pedley et al 2003:22).

2.14 PREHOSPITAL THROMBOLYSIS

In Britain and elsewhere, prehospital thrombolysis by paramedics or EMS has successful outcomes, but proper training of these staff is necessary (Pedley et al 2003:22). In Scotland prehospital thrombolysis delivered by paramedics with support from the base hospital, demonstrates the efficiency in reducing delays from call to needle time (Pedley et al 2003:22). With fully trained EMS staff in this field and the availability of the latest technology in the transmission of ECG to cardiologists it appears to be a solution for patients whose transport to treatment time would otherwise be delayed. In Denmark, Dowdy et al (2004:390) found that prehospital triage bypasses obstacles contributing to the delays. Dowdy et al (2004:394) recommend "aggressive" prehospital triage for timely thrombolysis. In Belfast, Ireland, a physician is available in the Mobile Cardiac Care Units (MCCU) to provide primary cardiac care, thus reducing delays in data analysis and decision making time. Patients receiving prehospital care consequently had lower in-hospital mortality rates (8.00% versus 13.00%) than those seen and treated at the hospital first (Dowdy et al 2003:391). The results of the Myocardial infarction Triage and Intervention study (MITI) by Lincoff and Topol (1993:1363), recommended that the triage be done swiftly and that treatment given rapidly in case of a patient suffering form AMI. However, concern is raised to the limitations of the training of ambulance personnel regarding the accuracy in the acquisition and interpretation of ECG, as this is not a 'basic' skill in paramedical training programmes. The paramedics overall true-positive rate of ST Elevation MI diagnosis was 49.00% compared with 88.00% of the cardiologists and the authors suggested including ECG as an essential skill in the paramedics educational program in efforts to reduce prehospital delays in interpretation of ECG. The authors recommended this strategy to other countries with similar geographical problems to administer early thrombolysis (Lincoff & Topol 1993: 1363).

Prehospital thrombolysis reduces the mortality rates in those patients who experience delays due to transport and living in rural out-of-reach areas (Dowdy et al 2004:392-394; Morrison et al 2000:2686). Rawles (1997:1118) found that prehospital thrombolysis would indeed contribute to reduced call to needle time. In their study in Northern Ireland, Harney, McClean, Rawles & Stewart (2003:19) found that the call to needle time of 90 minutes according to the set standard of the National Service Framework for thrombolysis could be achieved in rural areas.

2.15 ROLE OF EMERGENCY MEDICAL SERVICES

Emergency medical services and nurses have a vital role to play in the management of the AMI patient. They are the first line of contact from the time the patient calls till treatment time. Therefore it is mandatory that they are skilled, knowledgeable and committed to achieve the goal of <90 minutes from call to needle time or 30 minutes from door to needle time recommended by the NHAAP. This is considered the "golden hour" and is a vulnerable situation that dictates the final outcome for patient survival (Lincoff & Topol 1993:1361; Norris 2000:726). They should act with precision, dedication and commitment. Being the first people in contact with the AMI patient after symptom onset, their contribution to the "golden hour" cannot be overemphasised. This hour is crucial to the survival of the patient as the benefit diminishes with the passing of time. The role of those in the emergency room must also be emphasised. AMI patients should be treated with the same urgency and speed as that of a cardiac arrest (Edhouse et al 1999:325; Rawles 1997:1118).

Internists, cardiologists and emergency physicians should be responsible for thrombolytic therapy and familiar with all aspects of thrombolysis, including the indications, contraindications, available preparations, dosages and management of complications arising from treatment. Furthermore, they should cooperate with protocols and policies to facilitate the rapid and secure administration of thrombolytic therapy in emergency departments (Letovsky & Allen 1996:510).

2.16 CONCLUSION

From the literature review, it is evident that this condition has been widely researched. The quest for the perfect thrombolytic in the management of MI is ongoing. There has been a vast improvement in the agents used, the management of AMI patients and the goal to reducing mortality and morbidity rates. In the treatment of AMI the main objective of medical and nursing professionals is to reduce the high rates of mortality and morbidity. Sufficient evidence is available for personnel to act in time to save lives. Prehospital and in-hospital delays must be reduced in order to decrease the mortality and morbidity rates associated with AMI.

Chapter 3 describes the research design and methodology of this study.