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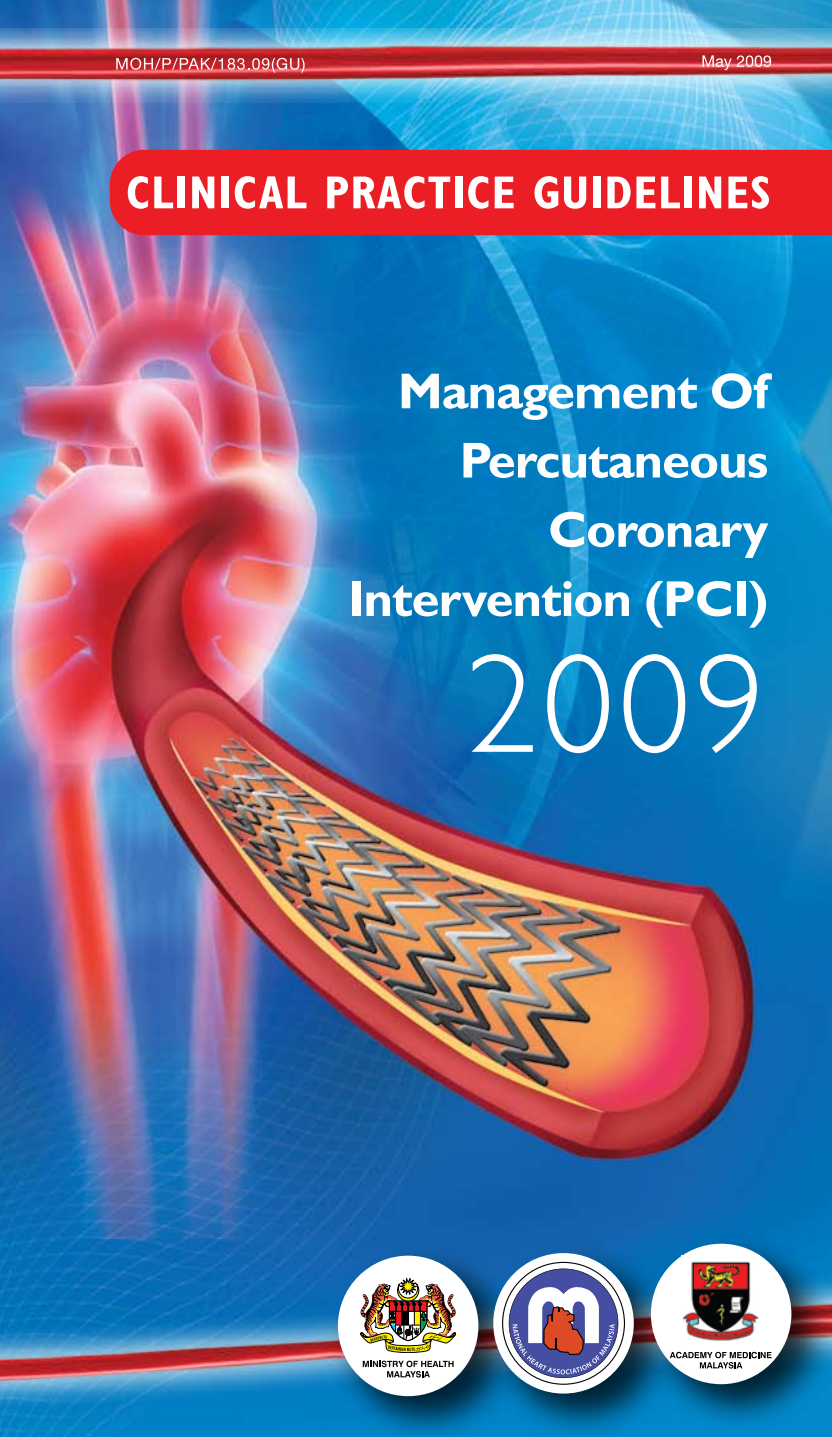
May 2009

CLINICAL PRACTICE GUIDELINES

Management Of Percutaneous Coronary Intervention (PCI) 2009



MINISTRY OF HEALTH MALAYSIA

NATIONAL HEART ASSOCIATION OF MALAYSIA

ACADEMY OF MEDICINE MALAYSIA

STATEMENT OF INTENT

This guideline was developed to be a guide for best clinical practice in the role and management of percutaneous coronary intervention (PCI) in patients with coronary artery disease. It is based on the best available evidence at the time of development. Adherence to this guideline does not necessarily lead to the best clinical outcome in individual patient care. Thus, every health care provider is responsible for the management of his/her unique patient, based on the clinical presentation and management options available locally.

REVIEW OF THE GUIDELINE

This guideline was issued in 2009 and will be reviewed in 2013 or earlier if important new evidence becomes available.

CPG Secretariat
Health Technology Assessment Unit
Medical Development Division
Level 4, Block EI, Parcel E
Government Offices Complex
62590 Putrajaya, Malaysia

Available on the following websites:

http://www.malaysianheart.org
http://www.moh.gov.my
http://www.acadmed.org.my

MESSAGE FROM THE DIRECTOR GENERAL OF HEALTH

Clinical Practice Guidelines for PCI

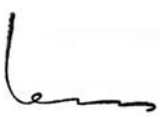
Treatment of ischemic heart disease has evolved rapidly over the last decade. In Malaysia, we have now published Guidelines on treatment of various aspects of heart disease, including hypertension and myocardial infarction.

Percutaneous coronary intervention (PCI) is now an established method of treating atherosclerotic coronary artery disease. The advent of modern stents, delivery systems and allied technologies has allowed interventional cardiologists in the country to improve their means of delivering a PCI service.

The wealth of evidence on PCI, both local and international, has led to an expert panel of interventional cardiologists being convened to draw up these Guidelines. Clinical evidence, technical 'tips and tricks' and information on other aspects of cardiovascular disease management, make these Guidelines useful for cardiologists and non-cardiologists alike.

While PCI is still a popular option for many Malaysian patients with documented obstructive coronary artery disease, it is not the only option. Aggressive pharmacotherapy and coronary artery bypass surgery are two other important avenues of treatment. Hence, these Guidelines serve to aid clinicians to help patients make informed consent about their treatment.

I congratulate the panel and the National Heart Association of Malaysia on these Guidelines, which I believe will be an important resource for all concerned.



Y. Bhg Tan Sri Datuk Dr Hj Mohd Ismail Merican
Director General of Health Malaysia

FOREWORD FROM THE PRESIDENT, AMERICAN COLLEGE OF CARDIOLOGY

The American College of Cardiology supports the use of Clinical Practice Guidelines to help improve the quality of care for all patients with cardiovascular disease. We believe these are particularly important steps in efforts to achieve better patient outcomes in those patients with serious disease. I congratulate the writing committee on this comprehensive set of guidelines. The National Heart Association of Malaysia has been a strong affiliate of the College. It has also been involved with clinical care registries to measure performance and adherence to Guidelines. This guideline provides recommendations for the use of percutaneous intervention in both stable and unstable coronary artery disease. The document is easy to read, contains key messages and also provides specific technique suggestions for complicated procedures.

The American College of Cardiology looks forward to further collaboration with the National Heart Association of Malaysia on future efforts to improve the care that we provide our patients with cardiovascular disease.

W. Douglas Weaver, MD, FACC
President (2008)
American College of Cardiology

Members of the Expert Panel

Chairperson:

Dr Robaayah Zambahari	Consultant Cardiologist, Institut Jantung Negara

Secretary:

Dr. Jeyamalar Rajadurai	Consultant Cardiologist, Sime Darby Medical Center

Members (in alphabetical order)

Dr. Aris Chandran	Consultant Physician, Hospital Sultanah Bainun
Dr. Choo Gim Hooi	Consultant Cardiologist, KPJ Selangor Specialist Hospital
Dr. Omar Ismail	Consultant Cardiologist, Hospital Besar Pulau Pinang
Dr. Rosli Mohd. Ali	Consultant Cardiologist, Institut Jantung Negara
Dr. Sree Raman	Consultant Physician, Hospital Tuanku Jaafar
Dr. Sim Kui Hian	Consultant Cardiologist, Sarawak General Hospital
Dr. Wan Azman	Consultant Cardiologist, University Malaya Medical Center

External Reviewers (in alphabetical order):

Physicians

Dr. Chan Hiang Chuan	Emergency Care Physician Sarawak General Hospital
Professor Chia Yook Chin	Consultant Family Physician University Malaya Medical Center
Dr. Kauthaman Mahendran	Consultant Physician Malacca General Hospital
Dr Paranthaman	Family Physician Klinik Kesihatan Jelapang, Ipoh
Dr Shanta Kumari	Consultant Physician Hospital Tuanku Ampuan Rahimah

Cardiologists

Dr. David Chew	Consultant Cardiologist Institut Jantung Negara
Dr. Tan Kim Heung	Consultant Cardiologist Sunway Medical Center
Dr. Oteh Maskon	Consultant Cardiologist Hospital UKM
Dr. Zurkurnai Yusof	Consultant Cardiologist Hospital USM

Cardiac Surgeons

Mr. Abdul Rahman Ismail	Consultant Cardiac Surgeon Hospital Sultanah Aminah, Johore Baru
Mr. Prashant Joshi	Consultant Cardiac Surgeon Sarawak General Hospital
Mr. Venugopal Balchand	Consultant Cardiac Surgeon Institut Jantung Negara

Cardiac Anaesthesiologist

Dr Jahizah Hassan	Consultant Cardiac Anaesthesiologist Hospital Besar Pulau Pinang

RATIONALE AND PROCESS OF GUIDELINE DEVELOPMENT

Rationale:

Coronary artery disease (CAD) is an important cause of morbidity and mortality in Malaysia. It can be treated by optimal medical therapy, percutaneous coronary interventions (PCI) and coronary artery bypass graft surgery (CABG). Recently there has been an increase in the number and complexity of PCI cases being performed in this country.

Objectives:

The objectives of this guideline are to critically evaluate the use of PCI in the management of CAD based on currently available literature. It aims to:

- assist health care providers in clinical decision making regarding the appropriate use of coronary revascularisation procedures
- improve patient outcomes following PCI
- improve the standard of care in patients undergoing PCI

This Clinical Practice Guideline (CPG) has been drawn up by a committee appointed by the National Heart Association of Malaysia, Ministry of Health and the Academy of Medicine. It comprises cardiologists and general physicians from the government and private sectors as well as from the Universities.

Process:

Evidence was obtained by systematic review of current medical literature on PCI for CAD using the usual search engines – PubMed, Medscape and Ovid. The other international guidelines (American and European) on PCI were also studied. After much discussion, the draft was then drawn up by the members of the Expert Panel and submitted to the Technical Advisory Committee for Clinical Practice Guidelines, Ministry of Health Malaysia and key health personnel in the major hospitals of the Ministry Of Health and the Private Sector for review and feedback.

The clinical questions were divided into major subgroups and members of the Expert Panel were assigned individual topics. The group members met several times throughout the development of the guideline. All retrieved literature were appraised by individual members and subsequently presented for discussion during group meetings. All statements and recommendations formulated were agreed collectively by members of the Expert Panel. Where the evidence was insufficient the recommendations were derived by consensus of the Panel. The draft was then sent to local external reviewers for comments. It was also sent to members of the American College of Cardiology and the European Society of Cardiology for feedback.

The level of recommendation and the grading of evidence used in this guideline was adapted from the American Heart Association and the European Society of Cardiology (ACC/ESC) and outlined on page 8. In the text, this is written in black on the outer margin.

Clinical Questions Addressed:

- What is the best management of patients with CAD based on currently available evidence?
- What is the role of optimal medical therapy, PCI and CABG in the management of CAD?

Target Group:

This guideline is directed at general practitioners, general and family physicians, medical officers, cardiologists as well as cardiac surgeons and anaesthesiologists.

Target Population:

All patients with CAD.

Period of Validity of the Guidelines:

This guideline needs to be revised at least every 5 years to keep abreast with recent developments and knowledge that is being learnt regarding PCI.

Implementation of the Guidelines:

The implementation of the recommendations of a CPG is part of good clinical governance. To ensure successful implementation of this CPG we suggest:

- Increasing public awareness of CAD and its therapies.
- Continuing medical education and training of healthcare providers on the roles of optimal medical management, PCI and CABG in the management of CAD.
- Clinical audit by the National Cardiovascular Disease Database – PCI Registry on all interventional cardiac procedures being performed in the country, both in public and in private hospitals.
- All mortality and morbidity following PCI should be investigated and reviewed by a selective in-house committee.

GRADES OF RECOMMENDATIONS AND LEVELS OF EVIDENCE

GRADES OF RECOMMENDATION	
I	Conditions for which there is evidence and/or general agreement that a given procedure/therapy is beneficial, useful and/or effective.
II	Conditions for which there is conflicting evidence and/or divergence of opinion about the usefulness/efficacy of a procedure/therapy.
II-a	Weight of evidence/opinion is in favor of its usefulness/efficacy.
II-b	Usefulness/efficacy is less well established by evidence/opinion.
III	Conditions for which there is evidence and/or general agreement that a procedure/therapy is not useful/effective and in some cases may be harmful.

LEVELS OF EVIDENCE	
A	Data derived from multiple randomised clinical trials or meta analyses.
B	Data derived from a single randomised clinical trial or large non randomised studies.
C	Only consensus of opinions of experts, case studies or standard of care.

Adapted from the American Heart Association / American College of Cardiology (AHA/ACC) and the European Society of Cardiology (ESC)

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TABLE 1: INDICATIONS FOR PCI IN STEMI

INDICATIONS	ACC/ESC Classification
Primary PCI in patients presenting < 12 hours of chest pain and :	
• < 3 hours and PCI time delay is < 60 mins	I, A
• 3-12 hours in a PCI center or PCI transfer delay < 2 hours	I, A
Primary PCI in patients presenting more than 12 hours of chest pain and continuing signs of :	
• Cardiac ischaemia, LVF and/or hemodynamic instability	IIa, C
Primary PCI in patients who have:	
• high risk features - section 2.1.1.(b)	I, A
• contraindications to fibrinolytics	I, C
Rescue PCI in patients with failed fibrinolysis and have continuing signs of :	
• Chest pain, LVF, hemodynamic instability and/or persistent hyperacute changes in the ECG	I, A
Facilitated PCI	III, A
Post fibrinolysis and :	
• Routine invasive angiography with view to PCI and stenting < in 24 hours in all patients	IIa, A
• Delayed selective angiography depending on presence of hemodynamic instability or residual ischemia	I, A
PCI of totally occluded vessel 3-28 days after MI and no reversible ischemia	III, B
PCI in Cardiogenic shock and:	
• Age < 75 years	IIa, B
• Age > 75 years	IIb, B

TABLE 2: INDICATIONS FOR PCI IN UA/NSTEMI

INDICATIONS	ACC/ESC Classification
High Risk Patients:	
Routine Invasive angiography in all high risk patients prior to hospital discharge	I, A
Delayed selective angiography depending upon presence of residual ischemia and hemodynamic instability	I, A
Low Risk Patients:	
- Routine invasive angiography in all patients who at low risk (negative cardiac biomarkers, normal ECG and/or TIMI score <3*)	IIb, C
- Only a small area of myocardium at risk	III, C
- Insignificant disease (less than 50% coronary stenosis)	III, C

* see Appendix V, page 79

TABLE 3: INDICATIONS FOR PCI IN STABLE CAD*

INDICATION FOR PCI	ACC/ESC Classification
In patients requiring revascularization, PCI may be considered in:	
- 1 or 2 vessel disease with lesion(s) amenable to PCI and a high likelihood of success	I, A
- 3 vessel disease and :	
• discrete lesions suitable for PCI	IIa, B
• complex lesions and ineligible for CABG	IIa, B
• complex lesions and eligible for CABG	IIb, B
• diabetes	IIb, B
- restenosis after PCI	IIb, B
- chronic total occlusions	IIb, B
- unprotected left main and:	
• high surgical risk and not eligible for CABG	IIa, B
• eligible for CABG	IIb, B
• reduced LV function and eligible for CABG	IIb, C
• associated 3-vessel disease	IIb, C

* The treatment of choice for patients with significant left main stem disease and 3- vessel disease is CABG[89,91].

1. INTRODUCTION

Cardiovascular disease (CVD) is an important cause of morbidity and mortality in Malaysia[1]. It accounted for about a fifth of the total burden of disease (admissions in government hospitals) in 2000. Coronary artery disease (CAD) and cerebrovascular disease accounted for 50% and 32% of the cardiovascular burden respectively[1]. In 2006, CVD was the commonest cause of deaths in government hospitals accounting for 24.2% of total deaths[2].

Management of CAD includes aggressive risk factor modification and lifestyle changes, medical therapy and revascularisation procedures. Revascularisation is by percutaneous coronary intervention (PCI) and coronary artery bypass graft (CABG) surgery.

In Malaysia, there has been an increase in the number of diagnostic and interventional cardiac procedures performed over the last few years. With technical improvement in devices and skills, more complex PCI cases are now being addressed.

The National Cardiovascular Disease (NCVD) - PCI Registry was initiated in 2006 to obtain data and for clinical audit.

The objectives of this clinical practice guideline are to critically evaluate the use of PCI in the management of CAD based on currently available literature. It aims to:

- assist health care providers in clinical decision making regarding the appropriate use of coronary revascularisation procedures
- improve patient outcomes following PCI
- improve the standard of care in patients undergoing PCI

For this purpose, this guideline is divided into 2 parts:

- Part A: The role of PCI in the management of patients with CAD
- Part B: Technical aspects of PCI as a revascularisation strategy Guidelines help in the management of patients. Not all eligible patients will have access to all the recommendations stated in this guideline. Patient care should be individualised and clinical judgement plays an important role in decision making.

PART A: THE ROLE OF PCI IN THE MANAGEMENT OF PATIENTS WITH CAD

2. INDICATIONS FOR PCI

2.1. ST Elevation Myocardial Infarction (STEMI)

Definition:
Myocardial infarction is myocardial necrosis due to acute total occlusion of the coronary artery.

The culprit vessel should be reopened as early as possible to prevent cell death and for myocardial salvage. Reperfusion may be achieved by either primary PCI or fibrinolytic therapy. Primary PCI is defined as intervention in the culprit vessel without prior thrombolytic therapy. (see Flow Chart 1, page 23)

I, A When compared to fibrinolysis, patients with STEMI treated by primary PCI have consistently been shown to have[3]:

- lower short term mortality
- fewer non fatal reinfarctions
- fewer intracranial hemorrhages and strokes

High risk patients have the greatest mortality benefit with primary PCI. The short term benefits persisted during long term (6-18months) follow–up[4,5].

Timing is one of several factors that should be considered when determining the appropriate reperfusion strategy. In patients undergoing primary PCI, the optimal door to balloon time should be within 90 minutes. However, with every 15 minute delay in the time between arrival at the door and restoration of TIMI 3 flow, mortality increases[6].

The mortality benefits of primary PCI is seen when the incremental delay to PCI (door to balloon time minus door to needle time) is no more than 60 minutes of the patient's arrival at the hospital[7]. A more recent study suggests that even if the incremental delay is up to 2 hours, primary PCI has mortality benefits beyond fibrinolytic therapy[8].

"TIME IS MYOCARDIUM"

Most of the trials comparing primary PCI to fibrinolytic therapy have been carried out by experienced operators with skilled support staff. Thus to obtain the same benefits as seen in these trials, it is important that primary PCI be performed promptly by experienced operators and in centers performing a sufficient number of primary PCI procedures.

2.1.1. Indications for Primary PCI (Table 1, page 12)

The following factors help guide the choice of reperfusion strategies:

- Time from symptom onset to first medical contact
- Time to hospital fibrinolysis (time from hospital arrival to administration of fibrinolytic therapy "door to needle time")
- PCI time delay (time from hospital arrival to balloon dilatation "door to balloon time" minus " door to needle time")
- Contraindications to fibrinolytic therapy (Appendix I, page 76)
- The presence of high risk features (section B)

The best reperfusion strategy will depend upon:

A) Time from onset of symptoms

Early presentation (within 3 hours)

If both PCI and fibrinolytic treatment options are readily available, they have been shown to be equally effective[9,10] except for the following situations where primary PCI is the preferred strategy: **I, A**

- fibrinolytic therapy is contraindicated (Appendix I, page 76) **I, C**
- presence of high-risk features [as listed in section 2.1.1.(B)] **I, A**
- PCI time delay [(door-to-balloon time) minus (door-to-needle time)] is less than 60 minutes[7] **I, B**

Late presentation (3 to 12 hours)

Primary PCI is preferred [3,10]. The door to balloon time should be within 90 min if the patient presents at a PCI capable facility[7]. **I, A**

If transferred from a center with no PCI facilities, it should be less than 2 hours (including transfer delay)[11,12] **IIa, A**

If the time delay to primary PCI is longer than as mentioned above, then fibrinolytic therapy should be given.

Very late presentation (> 12 hours)

Both primary PCI and fibrinolytic therapy are not routinely recommended except for the following patients:

- Severe HF **IIa, C**
- Hemodynamic or electrical instability **IIa, C**
- Evidence of persistence ischaemia **IIa, C**

B) Presence of High risk features

These include:

- Large infarcts
- Anterior infarcts
- LV failure

- Hemodynamic or electrical instability
- Cardiogenic shock
- Elderly patients
- Post revascularisation (post CABG and post PCI)
- Post infarct angina
- Previous MI

I, A Primary PCI is the preferred strategy in these patients[13,14,15].

The fibrinolytic agents available in Malaysia are streptokinase, tissue plasminogen activator and tenecteplase. (Refer 2nd CPG STEMI 2007)

2.1.2. Transfer of patient

Transfer of patients with STEMI to PCI capable centers should be considered in the following situations:

- **I, A** when fibrinolytic therapy is contraindicated or unsuccessful[16,17,18]
- **IIa, A** when cardiogenic shock occurs[13,14]
- **IIa, A** when symptoms have been present for more than 3 hours and PCI can be performed within 2 hours
- **IIa, A** in patients with high risk patients [listed in section 2.1.1 (B)] given thrombolysis within 6 hours at a non-PCI centre [19,20]

2.1.3. PCI Post Fibrinolysis

Following fibrinolysis, PCI may be performed as[21,22]:

- rescue PCI - for ongoing/recurrent ischemia
- immediate PCI [Facilitated PCI] - performed routinely immediately after fibrinolysis
- delayed routine PCI – stable patients undergo angiography and PCI irrespective of the absence or presence of myocardial ischaemia or viability
- delayed selective PCI – only patients with spontaneous or inducible ischaemia undergo angiography and PCI

2.1.3.1. Rescue PCI

I, A Rescue PCI is initiated as soon as there are features indicating failed fibrinolytic therapy manifested as:

- ongoing chest pains
- persistent hyper-acute ECG changes (< 50% resolution of ST elevation in the lead showing the greatest degree of ST elevation at presentation)
- hemodynamic and electrical instability
- heart failure

Rescue PCI is associated with a reduction in heart failure, reinfarction and a trend towards reduction in mortality, but with increased risk of bleeding and stroke[16,17,18]. Hence these patients should be individually evaluated.

2.1.3.2. Facilitated PCI

Facilitated PCI refers to a strategy of planned immediate PCI after an initial pharmacologic regimen consisting of either a fibrinolytic agent, glycoprotein (GP) IIb/IIIa inhibitors or a combination of these agents. The purpose is to bridge the delay between first medical contact and primary PCI.

This strategy however has not been shown to reduce infarct size or improve patient outcomes. It is also associated with an increase in mortality, recurrent ischaemia, reinfarction rates and major bleeding. It is thus not recommended [22-26]. **III, A**

2.1.3.3. Delayed routine angiography and PCI

This refers to stable patients post fibrinolysis undergoing angiography and PCI irrespective of the absence or presence of myocardial ischaemia or viability.

Recent studies show that routine angiography and PCI with stent implantation (as opposed to routine balloon PCI only) in the early hours after fibrinolysis improved patient outcomes as compared to symptom or ischaemia guided delayed intervention[16-19,21,27-32].

This strategy of immediate or early angiography with the intent to perform PCI with stenting as necessary, within hours of fibrinolysis (< 24 hours), has resulted in a significant reduction in mortality and reinfarction rates without an increase in adverse events. The optimal timing interval between fibrinolytic therapy and PCI is however still unknown. **IIa, A**

2.1.3. 4. Delayed selective angiography and PCI

This strategy refers to patients undergoing angiography and PCI only if there is spontaneous or inducible ischaemia.

Stable patients who are at low risk and who did not undergo early (< 24 hours) angiography should undergo stress testing[33,34]. If spontaneous or inducible ischaemia is present, then angiography and appropriate revascularisation should be performed. **I, A**

Routine PCI of totally occluded coronary arteries 3-28 days after STEMI is not recommended unless there is ischaemia demonstrated[35]. **III, B**

However if the patient is admitted to a non PCI center and is stable post fibrinolysis, an initial conservative approach with delayed selective angiography and PCI may be adopted guided by the attending physician's discretion. **I, A**

2.1.4. Technical considerations during primary PCI

For a favourable outcome, it is important to obtain good TIMI 3 epicardial flow as well as optimum reperfusion of the myocardial microvasculature (TIMI myocardial perfusion grade – TMP). (Appendix II and III, page 77)

2.1.4.1. Pre-procedure

- If breathless, the patient should be treated appropriately before being taken to the catheterisation laboratory.
- Optimise patient's haemodynamics and oxygen saturation.
- oral aspirin 300 mg
- clopidogrel 300-600 mg
- anti-thrombotic therapy: - heparin or
  - bivalirudin

  (For dosages see Table 5 & 8, page 36 and 41)
- Femoral access is usually preferred because this allows for the use of larger devices if necessary and the use of intra-aortic balloon pump (IABP) when indicated.

2.1.4.2. Technical Tips during Procedure

I, C
- Primary PCI should only be performed on the infarct related artery (IRA) because dilating a non-IRA at the same sitting may cause stress on too much of the myocardium acutely.

IIb, B
- Occasionally, complete revascularisation may be attempted on significant lesions in non culprit vessels when time and patient safety permit[36].
- A soft or floppy-tipped 0.014 inch streerable guidewire is preferred.
- When flow is re-established, reperfusion arrhythmias may occur.
- If thrombus is present, consider the use of an aspiration catheter.
- The first balloon is usually a smaller balloon than the reference vessel.
- Consider giving intra-coronary nitroglycerine to ensure that the vessel is not vasospastic and for appropriate stent sizing.
- Randomised trials have shown that bare metal stents (BMS) reduced restenosis and target vessel revascularisation (TVR) when compared to plain balloon angioplasty (POBA) but did not improve mortality or ventricular function[37,38]. Stents have become the strategy of choice for primary PCI.

2.1.4.3. Drug Eluting Stents (DES) vs BMS for STEMI

Both DES and BMS are effective in the setting of STEMI. Randomised trials have not shown any mortality advantage of DES over BMS. However, DES is associated with lower TVR without an increase in all cause mortality[39,40].

2.1.4.4. Distal Embolisation and the Use of Adjunctive Devices and Pharmacotherapy.

Thrombus burden is usually large if the patient presents late or the IRA is ectatic. Predictors of slow flow (TIMI 1 and 2 – Appendix II, page 77) and no-reflow (TIMI 0) of the IRA are[41]:

- vessel diameter ≥ 3.5 mm
- treatment of the right coronary artery
- higher TIMI thrombus score[42]
- angiographic findings such as :
  - "cut-off" sign (ie abrupt occlusion of the epicardial vessel) seen on the coronary angiogram
  - persistent contrast stasis just proximal and/or distal to the obstruction
  - longer lesions
  - accumulated thrombus of > 5 mm proximal to occlusion
  - floating thrombus

To prevent distal embolization the following devices have been studied:

- aspiration catheter:- In recent studies, aspiration of thrombus prior to PCI was associated with improved tissue reperfusion (TMP grade – Appendix III, page 77) and medium term survival when compared with conventional PCI[43,44,45].
- distal embolic protection:- meta-analysis showed that these devices had a neutral effect on mortality[43]
- Glycoprotein (GP) IIb/IIIa inhibitors - Abciximab therapy during primary PCI showed short term benefit especially in high risk patients[46-50]. The data on its effect on long term survival is however conflicting.

2.1.4.5. Management of No Reflow

No reflow (TIMI 0) or slow reflow (TIMI 1 and 2) may occur transiently or may persist after primary PCI.

No-reflow may occur as a consequence of:
- microvascular dysfunction from vasospasm
- distal embolisation
- endothelial injury

It is associated with poor recovery of LV function and a higher incidence of post MI complications.

Management includes:

- Intracoronary (IC) Nitroglycerin
- IC Verapamil 100 – 200 µg boluses
- IC Adenosine 100 – 200 µg boluses
- IC Nitroprusside 50 – 100 µg boluses
- Others: IC Papaverine, IC Nicorandil

2.1.5. Cardiogenic Shock

Cardiogenic shock is defined as a systolic BP of < 90 mmHg associated with signs of tissue hypoperfusion, and central filling pressure [pulmonary capillary wedge pressure (PCWP)] of >20mmHg or cardiac index of <1.8L/min/m.

Cardiogenic shock may occur after STEMI or Non ST Elevation MI (NSTEMI) and carries a very high mortality rate. It may be present at admission or may develop during hospitalisation (in-hospital onset). In Europe, the rate of cardiogenic shock at admission has remained the same but the rate of in-hospital onset has decreased. This was due to increased rates of primary PCI[51].

Cardiogenic shock is usually due to left ventricular pump failure although occasionally it may be due to right ventricular infarction or mechanical complications such as acute valvular insufficiency and ventricular septal rupture. Mechanical complications should be considered for early surgical repair although surgical risks are high.

I, A Emergency PCI or urgent CABG is the treatment of choice and should be considered early. Patients who are less than 75 years of age should be considered for PCI[13,52] whatever the time delay; the earlier the intervention the better the outcome.

I, B Recent data seem to indicate that selected patients older than 75 years also do better with primary PCI if this is done early[51,53,54].

2.1.5.1. Technical considerations in Cardiogenic Shock

Patients in cardiogenic shock should be treated appropriately with the early use of mechanical ventilation, inotropes and vasopressors. An IABP should be used early (preferably even before starting the procedure) to help maintain perfusion and to augment LV performance. In a number of small clinical studies,it has been shown to improve survival even in patients not undergoing PCI [55-58]. A recent meta-analysis however, showed mixed results[59]. The role of IABP in the management of patients in cardiogenic is currently being addressed in an ongoing trial[60].

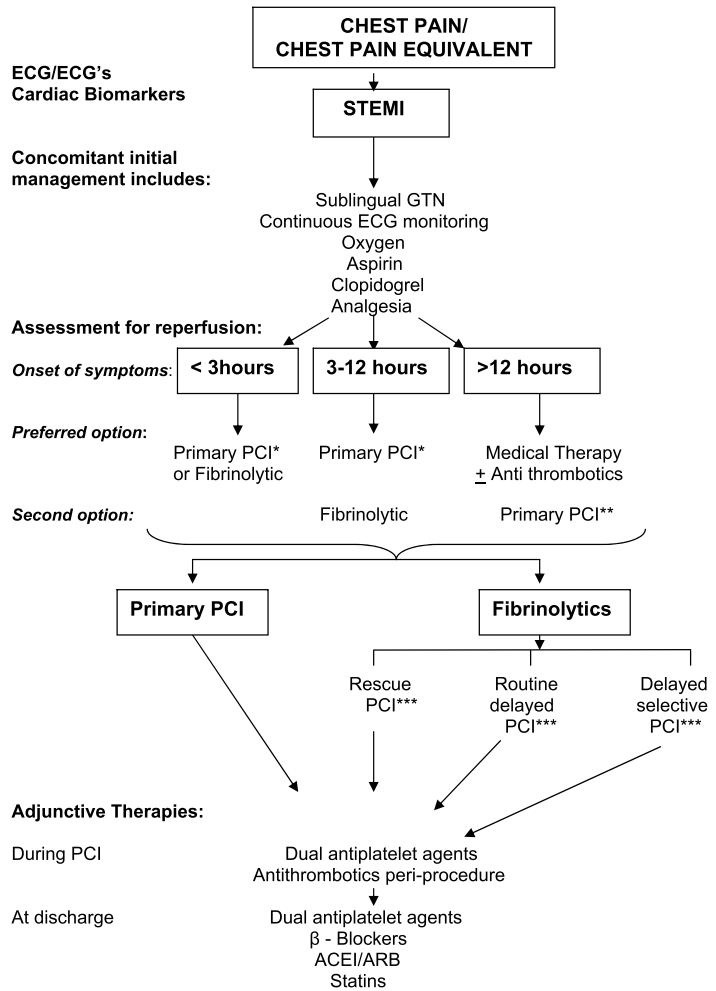
I, C Patients in cardiogenic shock often have multivessel disease and all critical lesions besides the culprit lesion, should be dilated taking into consideration the amount of contrast used and the length of the procedure. This is in contrast to the usual recommendation to only treat the culprit vessel in primary PCI for STEMI without cardiogenic shock. If multivessel PCI is not possible, then the patient should be evaluated for urgent CABG.

The use of stents and GP IIb/IIIa inhibitors has been associated with improved outcomes[36].

KEY MESSAGES:

- *Primary PCI is the treatment of choice in STEMI for all patients with high risk features and in those presenting between 3-12 hours of symptom onset.*
- *In patients presenting <3 hours, both primary PCI and fibrinolytic therapy are equally effective except in patients with high risk features and in those where the PCI time delay is < 60 minutes. In these cases, the treatment of choice is primary PCI.*

Flow chart 1: MANAGEMENT OF PATIENTS PRESENTING WITH STEMI



* *Preferred option in:* *- patients with high risk features,*
- contraindications to fibrinolytic therapy and/or
- PCI time delay of less than 60 minutes

*** when clinically indicated*

**** See text*

2.2. Unstable Angina / Non ST segment Elevation Myocardial Infarction (UA/NSTEMI)

Definition:
Unstable angina may be defined as[61]: (Appendix IV, page 78)

1. new onset of severe angina or accelerated angina; no rest pain
2. angina at rest within past month but not within preceding 48 hour (angina at rest, subacute)
3. angina at rest within 48 hour (angina at rest, acute).

It may be further classified according to clinical circumstances into either:

a) primary – absence of extracardiac disease
b) secondary – presence of extracardiac disease
c) post-infarct – chest pains occuring within 2 weeks of an acute MI

NSTEMI may be defined as MI as indicated by the history and elevation of cardiac biomarkers but with the absence of ST elevation in the ECG.

2.2.1. Risk stratification

Patients with UA/NSTEMI should be risk stratified as outlined in the CPG for UA/NSTEMI. The TIMI risk score is yet another risk stratification model that can be used to assist in decision making. This risk score is based on the patient's clinical condition at admission. (Appendix V, page 79)

Risk stratification is important because it will help decide:

- site of care – general ward or critical care ward
- intensity of medical therapy (e.g. need for GP IIb/IIIa inhibitors)
- invasive versus conservative strategy

2.2.2. Management strategy (Flow chart 2, page 27)

2.2.2.1. *Invasive strategy* (Table 2, page 13)

Patients requiring early angiography with view to revascularisation (invasive strategy) are those:

- at very high risk – in these patients urgent angiography may be necessary within 24 hours of admission
- at high risk – early angiography within hospital admission

I, B The following high risk patients should be considered for an invasive strategy:

- elevated cardiac biomarkers (troponins and/or CKMB levels)
- dynamic ST segment changes
- heart failure

The following high risk patients should also be considered for an invasive strategy: **I, C**

- Recurrent resting chest pain despite optimum medical therapy
- Worsening mitral regurgitation
- Reduced LV systolic function (LVEF< 35%)
- Haemodynamic instability
- Majorarrhythmias(ventriculartachycardia,ventricularfibrillation)
- History of known coronary artery disease (CAD), previous MI, prior PCI or CABG

These high risk patients require early angiography following intensive antithrombotic and anti ischaemic medications to "cool off" the plaque.

The value of medical stabilisation before angiography and the timing of intervention in these high risk patients have been assessed in 3 studies. In one study, patients randomised to immediate angiography (< 24 hours) had fewer deaths and MI's at 30 days compared to those whose angiograms were deferred to a mean of 86 hours[62].

Two recent studies however, have shown that even in moderate to high risk patients both the early invasive strategy (<24 hours) and the delayed invasive strategy (>24 hours but within that hospital admission) were equally effective and safe [63,64].

2.2.2.2. Conservative strategy

A conservative strategy involves optimal medical therapy and consideration for selective coronary angiography in those:

- who have recurrent chest pains at rest or on minimal exertion
- abnormal resting ECG, stress ECG or other tests for myocardial ischaemia

There have been a number of studies addressing the issue of routine early invasive therapy versus a conservative strategy with selective coronary angiography.

Meta-analysis of recent randomised trials of UA/NSTEMI have shown mortality and morbidity benefits in the routine early invasive strategy with appropriate revascularisation. This is as opposed to a conservative strategy with selective coronary angiography only in those with ischaemia[65,66,67]. **I, A**

It has also been found to be beneficial in women as well as in the elderly[68,69]. **I, B**

If the patient is admitted to a non PCI center with limitations for immediate/early transfer, guided by the attending physician's discretion and patient preferences, an initial conservative approach may be adopted[70]. **I, B**

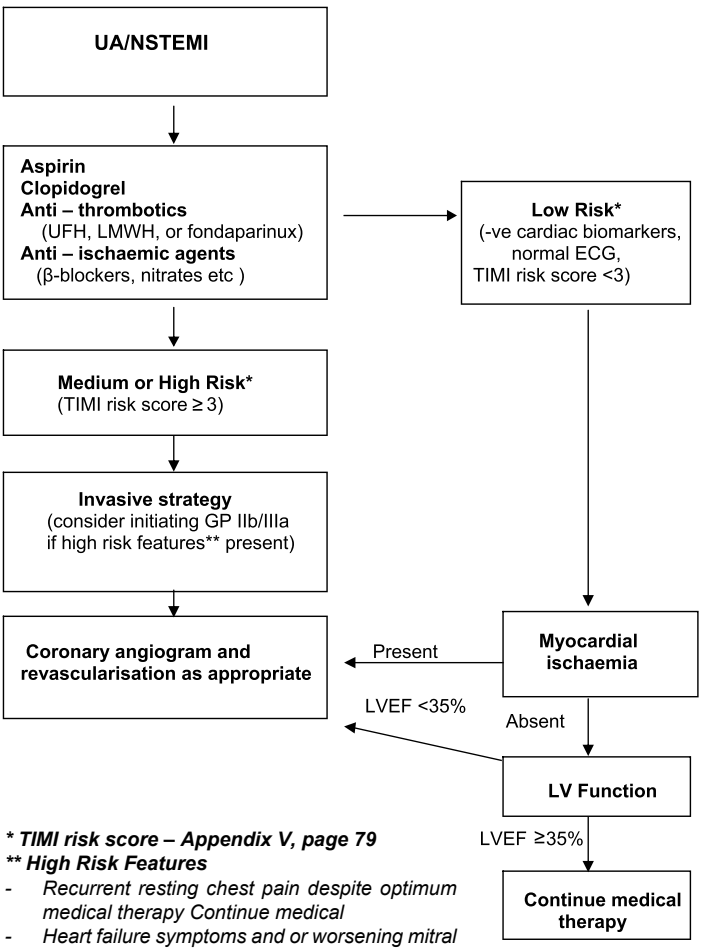
I, A These patients should have tests for myocardial ischaemia (stress tests, nuclear scans etc) and LV function. The presence of significant residual ischaemia (large anterior or multiple perfusion defects) and a depressed LV function is an indication for angiography and revascularisation.

IIb, C Low risk patients (negative cardiac biomarkers, normal ECG and/or TIMI risk score <3) can be treated conservatively. However a coronary or computer tomographic (CT) angiogram may be considered for diagnostic and prognostic purposes and for planning management strategy.

KEY MESSAGES:

- *All patients with UA/NSTEMI should be risk stratified.*
- *High risk patients should undergo early (in-hospital) coronary angiography and appropriate revascularisation.*
- *Low risk patients (negative cardiac biomarkers and normal ECG and/or TIMI score <3) can be treated conservatively and undergo non invasive tests for ischaemia.*

Flow chart 2: MANAGEMENT OF PATIENTS PRESENTING WITH UA/NSTEMI



**** TIMI risk score – Appendix V, page 79***
***** High Risk Features***

- *Recurrent resting chest pain despite optimum medical therapy Continue medical*
- *Heart failure symptoms and or worsening mitral regurgitation therapy*
- *Reduced LV systolic function (LVEF< 35%)*
- *Hemodynamic instability*
- *Major arrythmias (ventricular tachycardia, ventricular fibrillation)*
- *History of known CAD, previous MI, prior PCI or CABG*

2.3. Stable Coronary Artery Disease (CAD)

Stable CAD refers to stable angina, asymptomatic myocardial ischaemia and coronary atherosclerosis detected by coronary or CT angiogram. Stable angina is defined as a clinical syndrome characterized by discomfort in the chest, jaw, shoulder, back or arms, typically elicited by exertion or emotional stress and relieved by rest or nitroglycerine. (Appendix VI, page 80)

The objectives of treatment of stable CAD are to:

- minimise or relieve symptoms
- slow down /prevent progression of disease
- improve prognosis by preventing myocardial infarction and death

Treatment strategies include:

- medical therapy
- PCI
- CABG surgery

The choice of treatment strategy will depend on the:

- severity of symptoms (Appendix VI, page 80)
- degree of myocardial ischaemia
- coronary anatomy, severity and complexity of coronary stenosis and lesion morphology

2.3.1. PCI vs medical therapy

Meta-analysis of randomised trials comparing PCI vs medical therapy in patients with stable CAD concluded that PCI[71,77,73.]

- was more effective than medical therapy alone in relieving angina
- was associated with better exercise tolerance
- did not reduce the risk of death or myocardial infarction (MI)

A recent large study (done in the stent era) comparing an initial management strategy of PCI in combination with optimal medical therapy to optimal medical therapy alone showed that the invasive strategy:

- did not reduce the risk of death, MI, or other major cardiovascular events[74]
- provided small but significant incremental benefits in quality of life[75] i.e angina stability, angina frequency or limitation of exercise capacity. These benefits however disappeared by 36 months.
- provided a greater benefit (symptom relief) in those patients with more severe ischaemia and more frequent angina[75]

I, A Thus patients with stable CAD should be treated with optimal medical therapy using a combination of antiplatelet agents, statins, β-blockers and angiotensin converting

enzyme inhibitors (ACE-I)[76]. These medications have been shown to improve long term survival by preventing death, MI and other major cardiovascular events. The survival of patients post MI who were on all 4 medications (aspirin, β-blockers, statins and ACE-I) was greater than those on zero, one, two or three of these medications only[77,78].

Nitrates, calcium channel blockers and other anti ischaemic agents (such as trimetazidine and ivabradine) may also be added for relief of angina and for reducing myocardial ischaemia. Reduction in ischaemia was associated with a significant reduction in risk and better long term outcomes[79].

It is important to achieve risk factor treatment goals (Appendix VII, page 80). Patients who attained these treatment goals generally did better[78,80]. These medications should be continued long term provided that there are no contraindications.

2.3.1.1. Indications for revascularisation

The following individuals should be considered for revascularisation:

- patients with significant and/or disabling angina especially within 3 months of a recent MI[81]
- patients with large areas of ischaemia on non invasive testing
- those whose symptoms were initially well controlled but with recurrence of symptoms or objective evidence of worsening ischaemia on non invasive testing[74]

In general, all stable asymptomatic or minimally symptomatic patients should undergo testing for reversible ischaemia prior to coronary angiography. **I, C**

If this was not done, certain coronary angiographic features may help decide the need for revascularisation[81]:

- Subtotal occlusions supplying non infarcted myocardium
- Stenosis greater than 90%
- Significant complex lesions that are prone to develop total occlusions
- Reduced fractional flow reserve (< 0.8)[82,83]
- Minimal Luminal Area (MLA) <4.0 mm^2 in proximal 2/3 of epicardial vessels as assessed by intra-vascular ultrasound (IVUS)[84]

2.3.2. PCI versus CABG

Both strategies are equally effective for the treatment of symptoms. There is also no significant difference in mortality between the 2 strategies in randomised patients in clinical trials at 1, 3, 8 years[85] and 10 years[86]. To obtain the same long term clinical benefits as seen in patients undergoing CABG, it is important that patients undergoing PCI have complete revascularisation[87]. In general, repeat revascularisation procedures are less with CABG. With the use of stents, however, the need for repeat procedures following PCI has also been reduced by as much as 50%[88].

I, A CABG has been shown to have a survival benefit in high risk individuals with complex coronary anatomy (e.g. left main stem, triple vessel disease) [89,90]. These patients were often not included in the randomised clinical trials done in the pre-stent era.

In the early trials done in the pre – DES era, CABG has been shown to have a lower 5 year risk of death in patients with:

I, A • diabetes[85,88,91] (see section on Diabetes)

I, A • multi-vessel disease with impaired Left Ventricular (LV) systolic function (LVEF < 35%)

Patients with impaired LV function were not randomised in most of the trials. These patients are traditionally better treated with CABG although treatment needs to be individualised.

When compared to medical therapy, patients with significant left main stem narrowing (> 50%) do better with CABG. Most of the early trials of PCI for left main stem disease have used bare metal stents. Procedural success was high but there was high early restenosis and mortality[92,93]. More recent trials using DES have had more promising results[91]. When left main stem disease

I, A is associated with poor LV function, CABG is the preferred revascularisation strategy (see section on Left main stem disease).

A recent large trial comparing PCI (with DES) and CABG for patients with triple vessel CAD and left main stem disease showed that both procedures were equally effective in reducing death and MI[91]. Patients undergoing PCI however, had more repeat revascularisation procedures. Generally patients with more complex disease (higher "SYNTAX" scores[94]) did better with CABG. There was a lower incidence of strokes in patients undergoing PCI[85,91].

Ideally, the best strategy for revascularisation in a patient with CAD should be made by mutual discussion by a "heart team" consisting of cardiologists and surgeons taking into consideration the coronary anatomy, the presence of co-morbidity and the patient's preferences[89]. The patient and family must be informed of the advantages and disadvantages of each of the strategies[90,95].

Registry data indicate that when the choice of revascularisation strategy is guided by physician selection, the long term outcome is similar irrespective of the choice of revascularisation strategy – i.e. PCI or CABG[96,97,98].

2.3.2.1. Indications for PCI as a revascularisation strategy- Table 3, page 14

KEY MESSAGES:

- *All patients with stable CAD should receive optimal medical therapy consisting of antiplatelet agents, β-blockers, ACE-I, statins and anti-ischaemic drug therapy.*
- *Patients with significant angina or large areas of reversible ischaemia on non invasive testing should undergo appropriate revascularisation.*

2.4. Non-cardiac surgery in the post PCI patient

Patients with significant cardiac disease (unstable CAD, significant arrhythmias, decompensated HF and severe valvular stenosis) should be properly evaluated and treated prior to non cardiac surgery[99].

In patients with CAD, routine prophylactic coronary angiography and PCI is not recommended in stable patients undergoing non-cardiac surgery[100]. **I, A**

Patients with UA/NSTEMI, recent MI and Class III and IV angina (Appendix VI, page 80) should undergo appropriate revascularisation prior to elective surgery. Where PCI is the chosen revascularisation strategy, POBA or if stents are necessary, BMS should be used instead of DES. **IIa, C**

Patients post PCI with DES requiring elective or emergency surgeries pose significant challenges. These patients are exposed to the risks of either:

- possible life threatening surgical bleeding due to the continuation of their anti platelet therapy
- acute MI and cardiac death due to stent thrombosis resulting from the premature or inappropriate discontinuation of anti-platelet therapy.

The situation is aggravated by surgery itself which creates a prothrombotic and pro–inflammatory state. These risks must be carefully balanced against the risk of delaying the operation to such time as is considered safe to stop antiplatelet therapy[101,102]. Antiplatelet therapy should not be stopped casually.

The peri-operative physicians, anaesthesiologists and surgeons should contact the patient's cardiologist prior to surgery to discuss optimal patient management. Patients should also be advised to inform any healthcare provider who instructs them to stop antiplatelet therapy to consult their cardiologist first.

Low risk surgical procedures where bleeding is minimal or can be easily controlled such as routine dental procedures or simple surgical operations such as removal of skin cysts/ lumps should not justify cessation of dual antiplatelet therapy.

Wherever possible, elective surgery should be deferred for at least 4-6 weeks after BMS implantation and at least for a year after DES implantation.

If surgery cannot be delayed, clopidogrel should be stopped for a minimum of 5 days and preferably for 7 days prior to surgery and restarted as soon as possible after the procedure. Aspirin should be continued throughout the surgery if possible[103,104,105]. **I, C**

KEY MESSAGES:

- *Patients with DES should be managed optimally by the physician, cardiologist, surgeon and the anaesthesiologist prior to non cardiac surgery.*
- *Dual anti-platelet therapy should not be discontinued prematurely in patients with DES.*

3. ADJUNCTIVE THERAPIES FOR PCI

3.1. Antiplatelet agents

3.1.1. Oral Antiplatelet Therapy

3.1.1.1. Aspirin

I, C
- Patients on long term aspirin therapy undergoing elective PCI should continue taking their usual dose before the PCI procedure.

I, C
- Patients not on aspirin therapy should be given 300mg of aspirin at least 2 hours and preferably 24 hours before the PCI procedure. Enteric coated aspirin should not be given because of the slow onset of action.

I, A
- After the PCI procedure, patients should be on life long aspirin therapy[106].

I, A
- The daily long term aspirin dose should be 100-150mg indefinitely[106].
- The optimal loading dose and maintenance dose of aspirin following PCI is being addressed in an ongoing study (CURRENT/OASIS-7).

3.1.1.2. Thienopyridines

a) Clopidogrel

I, A
- A loading dose of clopidogrel 300-600mg should be administered before PCI[107-111]. This loading dose is important in patients admitted with STEMI and ACS[111,112].

IIa, B
- However, in patients with chronic stable angina undergoing PCI, a recent study found no benefit in pretreating with clopidogrel. It was found that giving clopidogrel in the catheterisation lab just prior to ad-hoc PCI did not result in an increase in ischaemic complications[113,114].

I, A
- In patients who have undergone PCI, clopidogrel 75mg daily should be given for at least 1 month after bare-metal stent implantation (unless the patient is at increased risk of bleeding; then it should be given for a minimum of 2 weeks)[115].

I, C
- After DES, clopidogrel should be given at 75mg daily for at least a year[116,117].

IIa, C
- In patients with an absolute contraindication to aspirin, it is reasonable to give a 300-600mg loading dose of clopidogrel, administered at least 6 hours before PCI. This is followed by a maintenance dose of 75-150 mg daily.

IIb, B
- The dose of clopidogrel may be increased to 150 mg per day if platelet aggregration studies show that there is less than 50% inhibition of platelet aggregation[118].

IIa, C
- Patients who are at high risk of very late stent thrombosis (eg. multiple overlapping stents, long stents, small vessels, ostial or bifurcation lesions, LMS, sub-optimal stent result), may be considered for long term dual antiplatelet therapy (beyond a year)[102].

b) Ticlopidine

I, A
- It may be considered as an alternative to clopidogrel following POBA or BMS implantation. It has however, not been investigated following implantation of DES.

- It is associated with neutropenia in 1% of patients[119]. Due to this safety reason, it is not commonly used in patients following PCI. Patients on ticlopidine should have their total white cell count monitored regularly for the initial 3 months.
- Patients who are not on ticlopidine should be given 250mg b.i.d. for at least 3 days prior to procedure. **I, C**
- Patients not on maintenance dose of ticlopidine may be given a loading dose of 500mg.
- Patients already on long term ticlopidine undergoing PCI may be continued at a dose of 250mg b.i.d[120,121,122]. **I, A**
- In patients who have undergone PCI, ticlopidine 250mg b.i.d. should be given together with aspirin for at least 1 month after bare-metal stent implantation (unless the patient is at increased risk of bleeding; then it should be given for a minimum of 2 weeks)[121,122,123].

c) Prasugrel

- A new antiplatelet agent, prasugrel, has been shown to be more effective than clopidogrel in reducing ischaemic events but was associated with increased bleeding[124,125].
- In a recent study, prasugrel was found to be more effective than clopidogrel in reducing cardiovascular death, non fatal MI and non fatal stroke in patients with STEMI. Only patients who subsequently went on to CABG had increased bleeding with prasugrel[126].

3.1.2. Intravenous Antiplatelet Therapy – Glycoprotein (GP) IIb/IIIa Inhibitors

- If clopidogrel is given at the time of an ad-hoc procedure, supplementation with GP IIb/IIIa inhibitors can be beneficial to facilitate earlier platelet inhibition than with clopidogrel alone[127,128]. **IIa, B**
- In STEMI, GPIIb/IIIa inhibitors may be given in the presence of intra-coronary thrombus. **IIa, C**
- In a recent small study, tirofiban administered in the pre-hospital setting prior to primary PCI, was found to be associated with significant ST segment resolution[129]. **IIa, B**
- In patients with high risk ACS, it may be administered as an upstream therapy or in the catheterisation laboratory (in-lab)[130,131]. **IIa, A**
- A recent study showed that patients with NSTEMI treated with aspirin, clopidogrel, and heparin, there was no benefit to the upstream use of the GP IIb/IIIa inhibitor, eptifibatide compared with provisional use immediately prior to PCI. Routine upstream use of eptifibatide increased major bleeding as well as the need for transfusion[132].
- In low to intermediate risk elective PCI patients, GP IIb/IIIa inhibitors do not confer additional benefits in those who are already pre-loaded with 600mg clopidogrel[133]. **III, B**

IIa, B • A meta analysis indicated that diabetics undergoing PCI benefited from abciximab[134].

For dosages see Table 4, page 35

3.2. Antithrombotic Therapy

These include:

- Unfractionated Heparin (UFH)
- Low Molecular Weight Heparin (LMWH)
- Bivalirudin
- Fondaparinux

I, C • Unfractionated heparin (UFH) should be administered to patients undergoing PCI.

IIa, C • Bivalirudin may be used as a substitute for heparin in patients with heparin-induced thrombocytopenia (HIT)[135].

IIa, A • It is reasonable to use bivalirudin as an alternative to UFH and GP IIb/IIIa inhibitors in patients undergoing elective PCI[127,136,137,138].

I, B • In patients with STEMI, the use of bivalirudin instead of UFH was associated with lower major bleeding and all cause mortality but with a small increase in stent thrombosis[137].

IIa, B • Low-molecular-weight heparin (LMWH) is a reasonable alternative to UFH in patients with UA/NSTEMI undergoing PCI[139]. A dose of enoxaparin at 0.75 mg per kilogram given intravenously (IV) yields bleeding rates similar to those for unfractionated heparin, with more predictable anticoagulation levels[140].

I, A • Fondaparinux is best used in UA/NSTEMI and STEMI patients treated conservatively.

III, B • Fondaparinux is associated with an increase in catheter-related thrombus and coronary angiographic complications. It is not recommended as the sole anticoagulant during PCI[141,142].

IIa, A • If fondaparinux is used in UA/NSTEMI and the patient requires an invasive strategy, UFH should be given during the procedure. When used in PCI, it is associated with lower bleeding rates than LMWH[141,142,143].

III, A • No benefit was seen with the use of fondaparinux in Primary PCI[142].

For dosages refer table 5, page 36.

TABLE 4: RECOMMENDED DOSAGES OF GP IIb / IIIa RECEPTOR ANTAGONISTS IN UA / NSTEMI AND DURING PCI*

Drug		Recommended Dosage
Abciximab (Reopro)	PCI	i.v. bolus: 0.25mg/kg for 10-60mins before the start of PCI Followed by continuous infusion of - 0.125ug/kg/min (max 10ug/min) for 12 hours
Eptifibatide (Integrilin)	Upstream Use	i.v. bolus: 180ug/kg Followed by infusion of 2ug/kg/min for 72 hours or hospital discharge In the case of PCI, infusion continued for 96 hours
	PCI	i.v. bolus: 180ug/kg Followed by infusion of 2ug/kg/min Then a second 180ug/kg bolus after 10 mins Infusion should be continued till hospital discharge, up to 18-24 hours
Tirofiban (Aggrastat)	Upstream Use	i.v. bolus: 0.4ug/kg/min for 30 mins Followed by infusion of 0.1ug/kg/min for 48-108hours In the case of PCI, the infusion should be continued for 12-24 hours after PCI
	PCI	i.v. bolus: 0.4ug/kg/min for 30mins Followed by infusion of 0.1ug/kg/min for 18-24 hours

** For doses in renal impairment see section 4.2.3, Table 8, page 41*

3.3. Other Agents

3.3.1 Cilostazol

- Cilostazol, a phosphodiesterase inhibitor, was shown to result in reduced rates of stent thrombosis when given as part of a triple anti platelet regime in patients with BMS[144]. **IIb, B**
- Studies have also shown that cilostazol at a dose of 100 mg bid resulted in significantly reduced rates of restenosis and TVR at 6 months without an increase in the rate of bleeding or stent thrombosis[145-148]. **IIb, B**

3.3.2 Statins

- Pre-treatment with statins 7 days prior to elective PCI has been shown to reduce post-procedure MI[149]. **IIa, B**
- A loading dose of statin pre-procedure has also been shown to reduce post-procedure MI in statin-naive[150] and in patients already on regular statins[151]. **IIa, B**

TABLE 5: DOSES OF ANTI-THROMBOTIC AGENTS IN UA/ NSTEMI AND DURING PCI*

AGENT	DOSING REGIMEN
UFH	
UA/NSTEMI	Initial IV bolus : 60 IU/kg (max 4000 IU) followed by infusion of 12 IU/kg/hour (max 1000 IU/hour) adjusted to maintain aPTT 1.5-2.0x normal
During PCI	**Loading Dose** : • Empirical loading dose: 5000-10000 IU, or • Weight adjusted loading dose: - Not receiving GP IIb/IIIa inhibitors: 70-100 IU/kg - Receiving GP IIb/IIIa inhibitors : 50-70 IU/kg **Further doses** if procedure is > 1 hour may be by: • Empirical weight adjusted doses : - Not receiving GP IIb/IIIa inhibitors: 60 IU/kg - Receiving GPIIb/IIIa inhibitors: 50 IU/kg • Guided by ACT monitoring - Not receiving GP IIb/IIa inhibitors maintain ACT: 250-300secs Receiving GP IIb/IIIa inhibitors maintain ACT: 200 secs
Enoxaparin	
UA/NSTEMI	Initial 30mg IV bolus and then 15 minutes later by: - sc 1.0 mg/kg every 12 hours if age less than 75 years - sc 0.75 mg/kg every 12 hours if age 75 years and above
During PCI	Depends on prior enoxaparin use: • No prior use : 0.5-0.75 mg/kg IV bolus • Prior use within 8 hours of PCI: no additional dose Prior use between 8-12 hours of PCI: 0.3 mg/kg IV. Supplemental UFH may also be given during PCI
Bivalirudin	
UA/NSTEMI	0.1 mg/kg bolus and 0.25 mg/kg/hour infusion
During PCI	Depends on prior bivalirudin use: • Prior treatment : additional 0.5 mg/kg bolus and increase infusion rate to 1.75 mg/kg/hour • No prior treatment: 0.75 mg/kg bolus and infusion of 1.75 mg/kg/hour
Fondaparinux	
UA/NSTEMI	Initial dose 2.5 mg IV and then 2.5 mg sc daily
During PCI	If used during PCI, additional 50-60 IU/ kg UFH is recommended.

** For doses in renal impairment see section 4.2.3, Table 8, pg 41*

4. SPECIAL CLINICAL CONDITIONS

4.1. Diabetes

Diabetics have higher cardiovascular morbidity and mortality following both CABG and PCI. Early studies showed that CABG [with left internal mammary artery (LIMA) to left anterior descending artery] was associated with a better long term survival than POBA[152,153,154]. This was due to:

- accelerated atherosclerosis. New lesions (plaque progression) were more frequent among diabetics. This occurred more commonly in arteries that were dilated during the initial procedure[155]. Accelerated disease progression has also been seen after surgical revascularisation.
- restenosis: restenosis rates were higher in diabetics and these frequently presented as occlusive restenosis[156,157]. The long term survival of these patients was worse than those diabetics without restenosis or those who presented with non-occlusive restenosis[158].

Diabetics especially insulin dependent diabetics with poor glycemic control (HbA1c > 7%) were more likely to have restenosis and adverse outcomes following PCI[159]. They also have worse outcomes following primary PCI for STEMI, the higher the blood glucose levels, the worse the prognosis[160].

The prognosis of diabetic patients following PCI has improved with the use of:

- GP IIb/IIIa inhibitors: In a meta-analysis, the use of abciximab, resulted in 1 year mortality rates in diabetic patients being the same as placebo-treated non-diabetics[134].
- stents: Stents, especially DES, has resulted in significant reduction in restenosis rates in diabetics although it still remains higher than in non-diabetics[88,91,161-164].

PCI in diabetic patients:

- is appropriate in “less severe” disease[165,166] i.e. 1 or 2 vessel disease with discrete lesions in combination with stents and GP IIb/IIIa inhibitors[167,168,169]. **IIa, B**
- with multi vessel disease – The optimal method of revascularisation is still being addressed in ongoing trials (e.g. BARI 2, FREEDOM). More recent trials comparing PCI with DES to CABG found that the 3 year combined rates of death, MI and stroke were similar for diabetics treated by stenting or by surgery. The diabetics however had a higher rate of repeat revascularisation[91,170,171,172]. **IIa, B**

Lesion characteristics, vessel size and clinical judgement can help guide the choice of revascularisation strategy. Generally patients with discrete high grade stenosis in large vessels do well with PCI. On the other hand, patients with long stenosis in diffusely diseased calcified vessels do better with CABG[88,91].

4.1.1. Technical considerations

- Wherever possible, stents, preferably DES, should be used.
- If there are no contraindications, abciximab should be used.

4.2. Chronic Kidney Disease (CKD)

4.2.1. Prognosis

In patients with CKD:

- PCI was associated with a higher in-hospital and long term mortality compared to patients without CKD; the higher the serum creatinine, the worse the outcome[173,174]. Even patients with a serum creatinine of 1.1 and 1.2 mg/100ml (96.8 and 105.6 µmol/l) had a non-significant trend towards higher mortality[175].
- and on renal replacement therapy (dialysis) CABG was associated with a better 2 year survival compared to PCI[176].
- the use of stents was associated with significantly better survival[175,177].

There is insufficient data at present on the best means of revascularisation in patients with less advanced stages of CKD.

In patients with ACS, the presence of CKD is an additional high-risk feature associated with increased mortality, the more severe the CKD, the higher the mortality. A recent meta-analysis showed that patients presenting as UA/NSTEMI and treated with an early invasive strategy had better outcomes[178].

All patients with CAD should be screened for kidney disease by estimating their glomerular filtration rate (GFR), looking for microalbuminuria and measuring the urine albumin: creatinine ratio. Estimated GFR can be calculated using the Cockroft-Gault formula (Appendix VIII, page 81).

Patients with CKD are at increased risk of:
- Acute Renal Failure Post Intervention
- Bleeding

4.2.2. Acute Renal Failure Post Intervention

Acute renal failure (ARF) following PCI is defined as 0.5mg/100ml (44.2 µmol/l) rise in serum creatinine levels from baseline or a relative increase of ≥25% from baseline, 2 to 7 days following contrast administration[179].

Diabetic patients with baseline serum creatinine values <2.0 mg/100ml (<176 µmol/l) are at higher risk than non-diabetic patients, whereas all patients with a serum creatinine >2.0 mg/100ml (>176 µmol/l) and poor LV function are at high risk for ARF[180,181].

Acute renal failure following PCI, is an independent predictor of 30 day and long term mortality and morbidity[180,181].

Possible causes of ARF include contrast nephropathy and cholesterol embolisation.

4.2.2.1. Contrast induced nephropathy

Acute renal failure due to contrast nephropathy is generally reversible. The serum creatinine peaks between 2 and 5 days after contrast exposure and returns to normal within 14 days[182].

Contrast induced nephropathy (CIN) is more likely to occur in:

- the elderly
- diabetics
- pre-existing renal impairment
- hypotension
- poor LV function
- dehydration

The optimal strategy to prevent CIN is uncertain. Preventive measures include[182]: (Table 6 and 7, page 40)

- using iso-osmolar, non-ionic, contrast medium[183] . A recent trial showed that low osmolar contrast medium was as safe as iso-osmolar agents[184,185]. (Appendix IX, page 81)
- discontinuation of nephrotoxic drugs, such as non-steroidal anti-inflammatory medications and metformin
- use of a minimum volume of contrast including staging of procedure
- provision of intravenous hydration
- administration of N-acetylcysteine[186,187]
- use of sodium bicarbonate[188,189]. The renoprotective effect of sodium bicarbonate is hypothesized as being due to urinary alkalinization making it less amenable to the formation of free radicals.

4.2.2.2. Cholesterol Embolisation

Acute renal failure may occur due to microembolisation of cholesterol particles into the renal vessels. It is often associated with cholesterol embolisation to other visceral organs and the peripheral vessels. It is associated with a high mortality.

4.2.3. Bleeding Risks

Patients with CKD have increased bleeding risks. This is partly due to platelet dysfunction and also because many cardiac drugs especially some anti thrombotic agents are excreted by the kidneys. In patients with CKD, their doses need to be adjusted to avoid excessive bleeding (Table 8, page 41). Bivalirudin and fondaparinux seem to be associated with less bleeding than heparin or enoxaparin[138,190].

TABLE 6: PREVENTION OF CONTRAST INDUCED NEPHROPATHY

	ACC/ESC Classification
Contrast Agent - Isomolar agent - Low osmolar agents - use minimal volume	 I, A IIa, B I, C
Avoid nephrotoxic agents eg NSAIDS,metformin	I,C
Saline Infusion	I,C
Sodium Bicarbonate	IIa,B
Acetylcysteine	IIb, B

TABLE 7: PREVENTION OF CONTRAST INDUCED NEPHROPATHY

AGENT	CONCENTRATION	DOSE / FLOW RATE
Sodium Chloride[183]	0.9% solution	Rate of 1.0-1.5 ml/kg/hr for 3h-12h before and 6h-24h after the procedure ensuring a urine flow rate of 150ml/hour Reduce rate to 0.5ml/kg/hr if LVEF<40%
Sodium Bicarbonate[187]	154mEq/L in 5%dextrose in water (154ml of 1000mEq/l of sodium bicarbonate + 850ml of 5% Dextrose)	3ml/kg/hr for 1 hour before the contrast followed by an infusion of 1ml/kg/hr for 6 hours after the procedure
N-acetylcysteine[186]		1200mg twice daily, one day before and one day after the contrast

TABLE 8: DOSAGES OF ANTITHROMBOTIC AGENTS IN CKD

	LOADING DOSE	MAINTENANCE DOSE
UFH	No change	No change
Enoxaprin	30mg IV	1mg/kg sc every 24 hours if CrCl < 30 ml/min
Fondaparinux	Avoid if Cr Cl < 30ml/min	Avoid if Cr Cl < 30ml/min
Eptifibatide	180mcg/kg	IV Infusion 1.0mcg/kg/min if Cr Cl < 50ml/min
Tirofiban	IV infusion 0.4mcg/kg/min for 30 mins	IV infusion 0.05mcg/kg/min if Cr Cl <30ml/min

4.3. Women

Women undergoing PCI:

- tend to be older and have a higher incidence of diabetes and other co-morbid illnesses.
- especially those less than 50 years of age had a much higher mortality following PCI than men [191,192].
- with ACS who were biomarker positive had better outcomes than when treated with a conservative strategy[68]

A recent large retrospective study over 25 years found that the procedural success rate following PCI was similar in both gender[193]. After adjusting for age and risk factors, however there were no gender differences in survival rates.

Women tend to have smaller coronary arteries and thus higher restenosis rates after POBA[194]. Coronary dissection and acute coronary occlusion are also more common in women. These complications are effectively managed with the use of stents. In fact, it has been suggested that stenting may be the primary reason for the improvement in cardiac outcomes with PCI in women[195].

4.3.1. Technical considerations

Women's smaller blood vessels predispose them to more vascular access site complications.

They also tend to have more bleeding complications with the use of anti-thrombotic agents and GP IIb/IIIa inhibitors.

4.4. Elderly

The elderly tend to have a higher rate of complications following both PCI[196,197] and CABG[198]. This includes death, MI, strokes, renal failure and vascular complications[196]. This is partly due to their more extensive

disease with calcified vessels. They also tend to have lower left ventricular function and more co-morbidity.

With the use of stents, procedural success is higher than with POBA and restenosis rates are comparable to that of younger patients[197,199,200].

Elderly patients presenting with ACS have better outcomes with PCI[69,199,200]. However the bleeding and vascular complication rates are higher.

Clinical decision should take into consideration the biological age rather than the chronological age.

4.4.1. Technical considerations

In view of their often calcified vessels, rotablation may sometimes be necessary prior to stent deployment.

Anti-thrombotic agents, GPIIb/IIIa inhibitors and X-ray contrast agents must be used judiciously.

4.5. History of bleeding diasthesis, bleeding gastrointestinal or previous hemorrhagic stroke

In these patients the choice of revascularisation strategy should be carefully balanced against the risks associated with bleeding. If PCI is the chosen strategy, POBA or using BMS should be considered.

PART B: TECHNICAL ASPECTS OF PCI AS A REVASCULARISATION STRATEGY

5. PCI DEVICES

5.1. Balloon catheters

Balloon catheters come in different sizes and lengths. The diameter sizes are between 1.25 to 5.0mm and lengths of between 5 to 30mm.

Their main uses are:
- to predilate a lesion to prepare for other device therapy eg stent deployment
- as a definitive therapy with successful POBA treatment being defined as < 50% residual stenosis
- to deploy balloon expandable stents
- post stent dilatation for better stent apposition
- to add support for wire and guiding catheter in treating complex lesions e.g. chronic total occlusions (CTO)

There are two terms that are frequently used in balloon dilatation:
- Nominal Pressure – this is the pressure at which the balloon attains its stated size e.g. a 3.0 mm balloon attaining this size at 8 Atm
- Rated burst pressure – it is the pressure beyond which there is a high probability that the balloon will burst

There are 2 different balloon systems:
- Monorail (Rapid exchange) – it is easy to use
- Over the wire (OTW) – it has the following advantages:
  - it gives better support especially in treating difficult lesions like crossing a total occlusion
  - it allows wire exchange which cannot be performed with the rapid exchange system
  - contrast may be injected directly into it to visualize distal flow
  - medications may be given through it

There are 2 types of coronary balloons:
- Semi-compliant balloon – this is the main workhorse balloon. It can increase in size by up to 0.25 to 0.5 mm at higher pressures. Its rated burst pressure is lower, typically between 12 to 16 Atm.

- Non-compliant balloon – this balloon minimally increases in size and its rated burst pressure can be as high as between 24 to 26 Atm. It is usually used to post dilate a stent for optimal results and to “crack” open hard lesions e.g. calcified or fibrotic lesions. The balloon profile is poor after initial dilatation and deflation. As such it may not be reusable.

5.1.1. Cutting Balloons

This device has 3 to 4 very fine blades within the folds of the balloon. When the balloon is expanded, the blades will cut into the tissue and produce controlled dissections. This in turn leads to less inflammatory

response and reduced neo-intimal proliferation. Conflicting results have been obtained in the treatment of de novo lesions with the cutting balloon as compared to POBA [201,202].

It is useful in:

- treating resistant lesions that may not "give way" to normal balloon dilatation
- treating focal in-stent restenosis (ISR). It avoids the occurrence of "watermelon seeding" (balloon slippage) that commonly occurs when a regular balloon is used. It was however found to be non superior to POBA[203].
- the treatment of bifurcation and ostial side-branch lesions as it results in less plaque shifting.

5.1.2. Focus force (Safe cut) Balloons

This balloon is used in the same way as a cutting balloon. It utilizes the very same guidewire in the artery to cut into the tissue. It may not cut as effectively as a cutting balloon but it has a lower crossing profile.

5.1.3. Drug-eluting Balloons

This balloon is coated with an anti-proliferative drug with a special coating to retain the drug whilst the balloon is being delivered to the target site. At present only the balloons coated with paclitaxel are available. Since the drug is coated onto a balloon it gives a more homogenous drug delivery to the tissue as compared to a DES whereby the drug is located only on the stent struts.

It has been shown to be better than POBA and the Taxus DES in the treatment of ISR with lower late loss, target lesion revascularization (TLR) and major adverse coronary events at 6 months and better event free survival at 12 months [204,205,206].

It may be useful in the treatment of small vessel disease. Studies are ongoing in the treatment of subsets of high risk patients e.g. in multi-vessel disease, diabetics and bifurcation lesions.

5.2. Stents

This metallic device is used to scaffold the vessel. Its uses include:

- treating dissections to prevent abrupt/acute closure
- preventing restenosis following suboptimal results after balloon dilatation – residual stenosis of > 30% following POBA.
- preventing restenosis in high risk lesions (e.g. chronic total occlusion, left main stem lesions and saphenous vein graft lesions)

Stenting reduces recurrence of ischaemic symptoms and re-intervention but do not affect mortality outcomes[36-40,207,208].

5.2.1. Bare Metal Stents (BMS)

Currently available coronary stents are made of either stainless steel 316L or cobalt chromium. The latter has thinner struts thus resulting in lower risk of restenosis. It is more flexible and conformable whilst at the same time having similar radial strength as the stainless steel stents. However it is less radio-opaque.

Coronary stents come in different sizes ranging from 2.25 to 5.0 mm in diameter and from 8 to 38 mm in length. Larger and longer stents are less deliverable. When dealing with a tortuous vessel, it is better to use a shorter stent.

Another consideration in the choice of a stent will be its side branch access. Good side branch access allows easier passage of devices through the stent struts.

Most stents can be delivered through a 5F guiding catheter (except for the larger stents which are >3.5 mm in diameter). Generally, for the simultaneous deployment of 2 stents, the minimum size of the guiding catheter should be 7F.

5.2.2. Drug Eluting Stents (DES)

The Achilles heel of angioplasty and stenting has been restenosis as a result of neointimal proliferation. If substantial, it can lead to significant in-stent restenosis (ISR). The rates of restenosis with BMS can be as high as 50% in certain situations e.g. CTO, long lesions, small vessels, diabetics, ostial and bifurcation lesions. In large vessels (>3.5 mm) with discrete lesions the restenosis rates with BMS is low.

Stents may be coated with antiproliferative agents to inhibit neointimal proliferation and therefore reduce the risk of restenosis. They act on specific sites in the cell growth cycle. The current agents used are the limus group e.g. sirolimus, everolimus, zotarolimus and biolimus and the taxol group i.e. paclitaxel.

The clinical studies were mainly conducted in uncomplicated (i.e. type A and B lesions). In the real world setting however, it is mainly used in complex lesions with a higher tendency for restenosis.

There are several concerns with DES:
- Cost consideration – DES generally cost more than BMS.
- Stent Thrombosis – section 6.8.1 (page. 55)

In making a choice between a BMS and DES, it is important to take into consideration the patient's risk for stent thrombosis, ISR and bleeding. If the patient is unlikely to comply with long term dual antiplatelet therapy, is at increased risk of bleeding or may need a non-cardiac operation in the near future, one should consider alternative strategies such as using BMS, endothelial progenitor cell capture stents or refer for CABG.

5.2.3. Endothelial Progenitor Cell Capture Stents

This stent is coated with antibody that captures circulating endothelial progenitor cells. These cells rapidly transform into endothelial cells. This leads to rapid healing with a functional endothelium. With this stent,

dual antiplatelet therapy is recommended for only a month followed by long term aspirin therapy.

A recent study however, showed that it was inferior to BMS in patients with STEMI due to a high incidence of adverse events, late lumen loss and stent thrombosis at 6 months[209].

5.2.4. Covered stents

These are useful for sealing coronary perforations and excluding aneurysms. They have a higher profile and are less trackable. They are also associated with higher rates of stent thrombosis and restenosis. These patients require long term dual anti platelet therapy.

5.2.5. Biodegradable (Bioabsorbable) polymers and stents

5.2.5.1. Biodegradable Polymer

One of the concerns with polymer based stents is the risk of inflammation that may predispose to stent thrombosis. Biodegradable polymer reduces this risk. A study has shown that they are as efficacious as other first generation DES but they have not been shown to be any safer at 1 year[210].

5.2.5.2. Biodegradable DES

The potential advantage of this type of stent is the avoidance of stent thrombosis. It also offers the possibility of allowing that stented segment to be grafted during CABG after it has degraded. Typically an ideal biodegradable DES will be degraded over 18 to 24 months after overcoming the problem of elastic recoil and neointimal proliferation.

These stents are currently being evaluated in ongoing trials.

5.3. Rotational Atherectomy (Rotablator)

This device rotates at very high speeds (target usually between 140,000 to 200,000 rotations per minute) to selectively break down the atheromatous plaque into very small particles which is then washed downstream. There is a steep learning curve in utilizing this technology.

Its use is now mainly limited to:

- debulking calcified lesions that may impede delivery of devices and good stent deployment
- pre-treating uncrossable and undilatable lesions prior to stenting

Adjunctive devices like a temporary pacemaker is required to avoid bradyarrhythmias particularly when dealing with right coronary artery and dominant left circumflex lesions.

5.4. Directional Atherectomy

This device is able to cut though atheromatous plaque and the "shavings" are then brought out from the catheter. It is used mainly for bulky lesions especially for LMS and ostial lesions. However directional atherectomy is rather cumbersome to use and the advent of DES has limited its usage.

5.5. Microcatheters

These catheters are mainly used in the treatment of CTO lesions. It lends support for the wire in crossing the CTO and also facilitates wire exchange.

5.6. Thromboaspiration catheters

These devices are useful in the treatment of thrombus-laden lesions especially during primary PCI. These catheters are effective in removing the thrombus and improving TIMI flow and myocardial perfusion (TMP flow) post-procedure. A recent meta-analysis showed that catheter thrombus aspiration during STEMI reduces mortality over a mean follow-up of 5 months[43,44,45].

5.7. Thrombectomy Devices

These devices are used in decimating thrombus during primary PCI for the same purpose as thromboaspiration catheters. Mechanical thrombectomy appeared to increase mortality during primary PCI[43].

5.8. Protection Devices

These devices help to protect the distal vessels to reduce distal embolization. Situations in which these devices are useful are in the treatment of thrombus laden vessels (especially in primary PCI) and in degenerated SVG intervention[211,212].

Protection devices may be placed either distal or proximal to the lesion. Distal protection devices come in the form of balloon occlusive devices and filter devices. Proximal protection devices are useful for distal SVG lesions that do not have an adequate landing zone. However this device cannot be used for ostial SVG lesions.

When used during Primary PCI, these distal protection devices had a neutral effect on mortality[43].

5.9. Laser Therapy

Besides being used in primary PCI to lyse thrombus, the laser device can be used in CTO lesions to create a channel to facilitate balloon passage before subsequent balloon dilatation and stent deployment.

5.10. Coil Embolisation

Coils are used to seal off persistent perforations created by wire manipulation and for closure of arterio-venous (AV) fistulae. These are delivered through a large lumen microcatheter.

5.11. Intravascular Imaging Devices

5.11.1. Intravascular Ultrasound (IVUS)

IVUS is the most common imaging device introduced on the guidewire. Its uses are:

- assessing the severity of borderline lesions
- assessing the degree of calcification
- assessing vessel size especially in small vessels, LMS
- aiding stent size selection and assessing results post-stent deployment eg stent apposition and deployment, edge dissections, coverage of ostial lesions, stent malapposition
- guiding wire crossing in CTO lesions

5.11.2. Optical Coherence Tomography

This device gives a more detailed imaging of the vessel wall as compared to images obtained from IVUS. It gives a clearer image of red and white thrombus, plaque rupture, plaque protrusion through stent struts and stent malapposition. However the depth of image tissue penetration is lower than those obtained from IVUS.

5.11.3. Virtual Histology

This imaging modality uses the same IVUS catheter but a special software program allows lesion characterization to be made. Atherosclerotic lesions can be divided into fibrous, fatty, necrotic, calcified and fibro-calcified components. Presently it is used mainly as a research tool for identifying vulnerable plaques.

5.11.4. Angioscopy

This is mainly an investigative tool. It allows direct visualisation of the vessel and can be used to observe thrombus, plaque, inflammation and stent apposition. However in order to visualise the vessel a balloon needs to be dilated proximally to obstruct flow during the whole duration of imaging. Thus care needs to be given to prevent the occurrence of ventricular fibrillation.

5.12. Others

5.12.1. Pressure Wire

Pressure wire is useful in the assessment of borderline lesions. The wire has a small transducer at the tip of a 0.014 inch wire which can be used as a regular guidewire.
Following bolus intracoronary adenosine injections, the pressure difference between the aorta and distal to the lesion is measured. A value of < 0.8 indicates a significant lesion[82,83].

6. LESION / DEVICE SPECIFIC CONDITIONS

6.1. Left Main Stem (LMS) Disease

The conventional treatment for unprotected LMS (>50%) is CABG. PCI of unprotected LMS is feasible and promising but the early studies have showed high morbidity and mortality rates[91,92,213-218].

With the use of DES, the results have improved and the incidence of adverse events has decreased. In a recent trial comparing the use of DES and CABG, both treatment strategies had similar rates of death and MI at 1 year[91].

When undertaking PCI for unprotected LMS disease the following are important considerations:

- anatomical location of the lesion – the results of PCI with DES for ostial and body lesions are better as compared to distal lesions involving the bifurcation
- LV function – in the presence of depressed LV function, CABG is the preferred strategy
- associated multi vessel disease – CABG is a better option

(Table 3, page 14 for recommendations and grading)

6.1.1. Technical considerations

PCI of the unprotected LMS should be done by skillful operators in high volume centers with surgical back-up.

PCI should be performed preferably with DES[216,217,218]. If a DES is used for a vessel that is >4.0 mm then it should be upsized appropriately. The stent must be well deployed and apposed. An IVUS is highly recommended to ensure optimal stent deployment. **I, C**

If the LV function is depressed and when dealing with high risk unprotected LMS lesions, IABP support is recommended. **I, C**

Close surveillance either by coronary or CT angiogram is recommended at about 3 to 9 months after the procedure. **IIa, C**

Long term dual antiplatelet therapy is recommended. **I, C**

6.2. Multi-vessel disease

An important factor determining treatment strategies in a patient with multi-vessel disease is the clinical status of the patient i.e. elective versus an urgent procedure.

6.2.1. Stable Coronary Artery Disease

The choice of strategy would depend upon:

- lesion characteristics – discrete lesions in multi vessels do well with PCI while long calcified lesions are better treated with CABG
- LV function – in the presence of depressed LV function, CABG is the preferred option
- diabetes – generally diabetics have higher restenosis rates with PCI (see section on diabetes)
- renal impairment – an important consideration is contrast nephropathy
- surgical risk and patient's co-morbidities
- cost constraints – the cost of multiple stents and the possibility of
- repeat revascularisation for restenosis versus CABG. A procedure with 2-3 DES may cost as much as CABG.
- patient's preferences

(Table 3, page 14 for recommendations and grading)

It is important that patients treated with PCI have complete revascularisation to obtain the same mortality benefits as seen with CABG[87,219].

All lesions may be dealt with at the same time or it may be staged depending upon the duration of the procedure, amount of contrast used and patient comfort and safety.

6.2.2. UA/NSTEMI

In the setting of ACS, it is recommended to treat the culprit lesion and stage the procedure. However in certain situations where the patient is stable and the anticipated procedure is uncomplicated, complete revascularisation may be attempted at the same sitting[36].

6.2.3. STEMI

In STEMI, where the patient is noted to require CABG as a definitive procedure, PCI of the infarct related vessel may serve as a bridge to stabilise the patient. Wherever possible, use of a BMS is advocated in this setting to avoid the risk of peri-operative (CABG) stent thrombosis.

The culprit lesion is usually identified by the site of the MI on the resting ECG and the presence of an ulcerated plaque with thrombus. Occasionally it may be difficult to identify the culprit lesion angiographically.

6.3. Chronic Total Occlusions (CTO)

CTO is defined as coronary occlusion of >3 months duration.

Patients with CTO and having significant ischemia should be revascularised. Studies have shown that this improves the symptoms and exercise tolerance, enhances LV function and improves survival[220,221].

The indications for PCI in CTO include:
- presence of symptoms (angina or heart failure) and/or

- objective evidence of ischemia in CTO territory with other vessels suitable for PCI
- absence of significant LMS disease
- contraindications for CABG

PCI for CTO has a steep learning curve with the use of additional hardware and different techniques. It is also associated with a higher complication rate (e.g. coronary perforation and cardiac tamponade). Hence it requires experienced, skillful operators performing in high volume centers with cardiothoracic surgical back-up.

Certain lesion characteristics favor successful recanalisation with PCI. (Appendix X, page 82)

6.3.1. Technical Considerations

Generally an antegrade approach is utilised aided with contra-lateral injections of contrast to delineate the distal segment. Retrograde and Control Antegrade and Retrograde Techniques (CART) techniques should be performed only by experienced operators.

Challenges in CTO intervention include:

- good guide support – sometimes “mother and child” technique (2 guiding catheters – 1 bigger and 1 smaller) is utilised for better support
- wires for crossing the lesion – these include 0.010 inch tip, intermediate wire, stiff hydrophilic or polymer coated wire (from the Miracle and Conquest series). These special wires are used for penetration of CTO lesion with innovative techniques which include parallel wire and anchor balloon.
- devices for crossing the lesion – these include OTW and small balloons, microcatheter, Tornus, rotablation
- IVUS guidance may be used to help identify the true lumen

Radiation dose to the operator can be reduced by lower dose (kV) setting, extra shield, pulsed fluoroscopy and extra collimation. Radiation dose to the patient can be reduced by lower dose (kV) setting and avoiding extreme angulations.

Indications for stopping the attempted procedure:

- Excessive contrast (> 600 ml in non-diabetic with normal renal function)
- Complications (false lumen, excessive staining)
- Long procedure

DES is preferred for CTO[222].

6.4. Bifurcation Lesions

About 15-20% of PCIs involve a bifurcation lesion[223]. Generally, these are technically more challenging with greater complication rates and poorer long term outcomes.

6.4.1. Classification

There are many different classifications for bifurcation lesions. The preferred is the Medina classification[224]. It however does not provide details of the angle of bifurcation and the size of the proximal healthy segment which are important determinants of success and long term outcome. (Appendix XI, page 83)

It is important to make the distinction of whether it is a 'true' bifurcation or a 'non-true' bifurcation lesion.

6.4.2. Technical Considerations

A number of strategies have been described and used to treat bifurcation disease[223]. These include:

- simple strategy – one that involves a single-stent.
- complex strategies – involve double (or multiple) stents for bi-/tri-furcation lesions
- dedicated bifurcation stent – still in development

Different techniques which are often utilized are:

- V stenting
- T stenting
- Culotte
- simultaneous kissing stents
- minicrush, reversed crush

Most bifurcations can be treated with a single-stent strategy in the main vessel with a provisional plan for a second stent implantation in the side-branch in the event of suboptimal results[223,225,226]. The definition of suboptimal result varied among the different trials. It will depend upon the size of the side-branch[223].

The 2-stent strategy tends to be more time-consuming, uses more contrast and is related to more biomarker release. It may look better angiographically immediately after the procedure, but, in the long term is associated with greater restenosis, TVR rates and stent thrombosis[226,227,228].

If the 2-stent strategy is utilised, DESs are preferred[223]. In post stent deployment it is crucial to have kissing balloon inflation especially in the crush and Cullote techniques[229,230]. There are some studies that suggest that simultaneous kissing balloon inflation after each stent deployment may further improve long term result (Double Kissing-Crush technique)[231].

An IVUS is generally recommended when a large area of myocardium is at risk e.g. LMS bifurcation disease.

6.5. Ostial Lesions

Ostial lesions are usually defined as lesions within 3mm of the take-off of a major coronary artery. Native aorto-ostial, aorto-graft-ostial and branch-ostial lesions can be distinguished.

Treating ostial lesions is technically difficult and is associated with a higher risk of complication and re-stensosis rates.

6.5.1. Technical considerations

- Precise placement of the stent is important to ensure that the ostium is well covered and to avoid excessive jutting of the stent struts into the main vessel.
- Ideally the ostium needs to be 'well prepared' prior to stent deployment.
- The vessel needs to be dilated appropriately (balloon sized to the vessel size) before stent deployment to allow for good stent expansion. This will reduce the risk of re-stenosis.
- Directional atherectomy may be useful to debulk the lesion first.
- DES is preferred.

Problems that may occur include:

- fall in BP when engaging the vessels – a smaller size guiding catheter or the use of side holes may help alleviate this.
- risk of dissection – the dissection may spiral down the vessel and occasionally it can occur retrogradely into the aortic root. This complication may be due to guiding catheter manipulation.

6.6. Saphenous Vein Grafts (SVG)

Following CABG:

- between one and six years, the annual graft attrition rate is 1% to 2% and becomes 4% to 6% per year after that, so that about half of SVGs have significant stenosis or are occluded after 10 years.
- up to 15% of SVGs are closed within 1 year[232,233,234] and by 10 years, nearly a third of patients require repeat revascularisation[235].

This could be due to new disease in vessels not previously bypassed, progressive disease in native vessels beyond the graft anastomosis, or disease in the bypass grafts themselves.

Treatment options for Saphenous Vein Graft Disease include:

1. Redo-CABG
   - Redo-CABG is associated with 2- to 4-fold higher risk than the initial CABG, with periprocedural deaths in 2-5% and myocardial infarctions in 2-8% of patients. Five- and 10-year survival rates are 84-94% and 75%, respectively[236,237].

- Difficulties in redo-CABG include:
  - risk of injuring the other patent grafts especially the internal mammary artery
  - patient subsets who tend to be older and sicker with more diseased target vessels, poorer LV function, availability of conduit and serious co-morbid medical problems

2. PCI
   - the main limitation of POBA in SVGs is the high restenosis rates of up to 23-73% of patients within 6 months and the risk of distal embolisation
   - DES is a reasonable option but its definite role remains to be defined
   - PTFE-covered stents may be useful for treatment of graft rupture or aneurysm

Some trials comparing PCI and repeat CABG demonstrated less in-hospital death and MI after PTCA, but more complete revascularisation and less target lesion revascularisation (TLR) at 4 years after repeat CABG[238,239].

6.6.1. Technical considerations during SVG Percutaneous Intervention:

IIa, B

Degenerated SVGs are characterised by friable plaques with overlying thrombus which increases the procedural risks of distal embolisation manifesting as slow or no-reflow phenomenon. As such the use of protection devices is strongly recommended[211,212, 240]. (section 5.8, page 47) Thrombectomy devices may be considered when there is a significant thrombus burden is present.

GP IIb/IIIa inhibitors have not been found to be helpful in SVG intervention[241,242]. Vasodilators eg. adenosine, verapamil, sodium nitroprusside may be used for situations of slow-flow or no-reflow.

6.6.2. Arterial conduit – Internal Mammary Artery (IMA)

Angioplasty and stenting procedure to the IMA has high success rates with less acute complications of abrupt closure, distal embolisation, acute myocardial infarction or need for emergency surgery.

Technical issues related to IMA percutaneous intervention include:

- good guiding catheter support
- IMA tortuosity
- danger of dissecting the ostia of the IMA
- may require shorter guiding catheters and longer wires and balloon catheters to reach a distal lesion

6. 7. Coronary Artery Aneurysm

The optimal treatment of coronary aneurysms remains controversial. Coronary aneurysm may lead to ischemia and MI. Surgical therapy is the treatment of choice[243,244].

Percutaneous intervention is an emerging strategy using autologous vein graft–coated stents[245] and PTFE-coated stents[246] with a good short-term angiographic result. It is associated with stent thrombosis and these patients should be on long term dual antiplatelet therapy.

6.8. Stent Related Complications

6.8.1. Stent Thrombosis

Stent thrombosis is a serious complication as it may result in MI and death. The mortality rate can be as high as 45%[247]. It can be classified as definite, possible or probable according to the Academic Reseach Consortium (ARC) classification[248].(Table 9, page 55)

TABLE 9: Definition of Stent Thrombosis as proposed by the Academic Research Consortium (ARC)[248]

Definite stent thrombosis	It is diagnosed when either angiographic or pathological confirmation is present - Angiographic confirmation of ST*: The presence of a thrombus originating in the stent or in the segment 5 mm proximal or distal to the stented region and at least one of the following criteria within a 48-h time window: • Acute onset of ischemic symptoms at rest (typical chest pain of 20 min) • New ischemic ECG changes suggestive of acute ischemia • Typical rise and fall in cardiac biomarkers - Pathological confirmation of stent thrombosis: Evidence of recent thrombus within the stent determined at autopsy
Probable stent thrombosis	It is diagnosed after intracoronary stenting in the following cases: • Any unexplained death within the first 30 days, regardless of the time after the index procedure • any MI that is related to documented acute ischemia in the territory of the implanted stent without angiographic confirmation of ST and in the absence of any other obvious cause
Possible stent thrombosis	It is diagnosed with any unexplained death from 30 days after intracoronary stenting until the end of trial follow-up

* The incidental angiographic documentation of stent occlusion in the absence of clinical signs or symptoms (silent occlusion) is (for this purpose) not considered a confirmed stent thrombosis.

It may occur as:

- acute (occurring within 24 hrs) – this is mainly due to mechanical causes e.g. stent not well deployed or not well apposed or undetected edge dissection. The incidence is less than 1%[249]
- Sub-acute (1 to 30 days) – this may be due to mechanical causes, platelet resistance or premature discontinuation of dual antiplatelet agents. The incidence is less than 1 %[249]
- Late stent thrombosis (LST) - 30 days to 1 year
- Very late stent thrombosis (VLST) - > 1 year

Acute and subacute stent thrombosis may occur with both BMS and DES.

LST and VLST may be due to various factors:
- discontinuation of antiplatelet agents
- stent factors (late stent malapposition, aneurysm formation, hypersensitivity to polymer)
- vessel (non-healing with poor endothelisation)

The annualized risk for VLST is 0.6% per year[250,251]. It is more common with DES than BMS[252].

6.8.1.1. Management of Stent thrombosis

Urgent re-PCI is the treatment of choice[253]. Most thrombotic stent occlusions can be treated with balloon angioplasty alone, aided by thrombus aspiration. Glycoprotein IIb/IIIa antagonists may be administered to improve microvascular reperfusion and to overcome increased platelet aggregation[253].

Systemic fibrinolysis should be considered in the presence of ongoing significant ischemia and unavailability of prompt PCI. If platelet aggregation studies reveal insufficient (<50%) inhibition of platelet aggregation with standard dual antiplatelet therapy, a higher dose clopidogrel - 150 mg/day- should be considered[119].

Additional stent implantation should be limited to bail out significant residual dissections. The implantation of a second stent for stent thrombosis is associated with a worse 6 month outcome[254].

PCI for stent thrombosis due to either BMS or DES have similar poor outcomes with low rates of reperfusion and high rates of death and adverse cardiac events[254]. This further highlights the importance of preventing stent thrombosis and choosing the appropriate revascularisation strategy for the individual patient.

In preventing stent thrombosis, it is important to consider[253]:

- Patient factors: Patient compliance and absence of contraindication to dual antiplatelet therapy is pivotal during the decision making process for stent selection[254].
- Technique: The stent must be well deployed and fully expanded throughout its entire length. This can be done using a short non compliant balloon at high pressure. Care should be taken to avoid dissections. If it occurs, it should be

treated appropriately. It is important to avoid excessive stent length and usage of multiple overlapping stent[255] since this correlates with stent thrombosis.
- Anti platelet therapy: It is crucial that dual antiplatelet therapy not be discontinued prematurely[256]. It should be continued for at least a year and in some complex cases, long term.

6.8.2. In-stent Restenosis (ISR)

Balloon angioplasty is associated with up to 40% risk of restenosis[207]. BMS have reduced the risk of restenosis but the rates of ISR remains considerable (17-32%)[208].
With DES, the rates of restenosis have been further reduced (0-9.1%)[257,258] depending on the complexity of the lesion and the type of stent used.

Restenosis may be due to elastic recoil, vascular remodelling and neo-intimal hyperplasia. It may be:

- focal
- diffuse
- proliferative

(Appendix XII, page 84)

Some predictors of ISR are:

- diabetes mellitus
- acute coronary syndromes
- Small vessel
- Long lesions requiring long or multiple overlapping stents
- SVG
- CTO
- Ostial lesion
- Bifurcation lesion

Prevention of ISR involves using DES and optimal stent implantation techniques. These include:

- adequate stent coverage of all segments pre-treated with balloon dilatation
- high pressure balloon dilatation to ensure adequate stent wall apposition
- prevention of stent edge injury with careful balloon post-dilatation within stent margins using shorter post-dilatation balloon
- using IVUS to optimise results

In managing ISR it is important to use IVUS to ascertain if the stent is well deployed. It will also allow the assessment of plaque volume which will help determine management strategy. Management includes using:

- POBA – may be adequate for treating focal ISR[259,260]
- cutting balloon – results are variable and is useful to prevent “watermelon seeding” (balloon slippage)[203].

- rotational atherectomy– results are variable[261,262].
- directional atherectomy – results are no better than POBA[259].
- DES implantation - superior to POBA and in some instances better than brachytherapy[263,264,265]. For DES ISR, the use of another DES with a different drug group may be considered.
- Drug Eluting Balloon[204,205,206] – section 5.1.3,page 44
- Brachytherapy – both catheter based gamma and beta irradiation have been shown to reduce ISR by about 50-60% when compared to POBA[266,267,268,269]. Radiation therapy however is associated with increased risk of edge restenosis ("candy-wrapper effect") and LST.

7. POST PROCEDURE COMPLICATIONS

The femoral arterial sheath may be removed if the ACT is < 180secs. In patients, who had received enoxaparin, sheath removal may be performed 4 hours after the last intravenous dose or 6-8 hours after the last subcutaneous dose. Use of closure devices e.g. Angioseal, Perclose allow immediate removal of sheaths.

7.1. Vascular access complications

7.1.1. Retro-peritoneal hematoma

This is more common after a 'high' groin puncture. It may not be detected early as the bleeding occurs in the retro-peritoneal space. One should suspect this complication if the patient develops unexplained tachycardia, pallor or hypotension after the procedure. This can be confirmed by ultrasound or computed tomogram (CT) scan of the abdomen.

Management includes:

- IV fluids
- blood transfusion
- reversal of coagulopathy may be considered
- using a covered stent to seal off the femoral site perforation
- vascular surgical consult may be necessary if there is persistent or recurrent hypotension

7.1.2. Pseudo-aneurysm

Pseudo-aneurysm may be suspected if there is a bruit over the puncture site. It can be confirmed by ultrasound. Most times this can be managed conservatively by prolonged compression preferably guided by ultrasound. Occasionally, vascular consult may be necessary.

7.1.3. Arterio-Venous (A-V) Fistula

This can be prevented by avoiding a through-and-through puncture of the artery and vein. Most A-V fistula can be treated conservatively.

Most of these access site complications are more common with femoral rather than with radial punctures. Thus radial punctures are generally preferred[270,271]. However the radial artery is also a good arterial conduit during CABG with good long term results[272,273]. Thus the choice of access will depend upon the patient characteristics, the operator and the institution.

7.2 Acute Renal Failure Post Intervention

Section 4.2.2, page 38

8. LONG TERM FOLLOW UP AND CARE

The objectives of follow-up post-PCI patients are:

- to look for recurrent symptoms
- for secondary prevention

8.1. Evaluation of Ischemia

Neither exercise testing nor any form of imaging has been proven to be beneficial for the routine, periodic monitoring of asymptomatic patients after PCI without specific indications.

For high risk patients (e.g. diabetes mellitus and suboptimal PCI results) stress imaging is preferred to evaluate for ischemia after PCI.

8.2. Secondary Prevention

It is important that the patient should adhere to medical therapies and secondary prevention programs to prevent progressive disease. (Appendix XIII, page 85)

9. RADIATION PROTECTION

The largest source of radiation comes from medical radiation and the largest users of medical radiation are interventional cardiologists. It is important to be know the biohazards of radiation.

Interventional cardiologists should be aware of radiation protection. This entails reducing the radiation exposure to as low a level as reasonably achievable to patients, medical staff and themselves.

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APPENDIX I: CONTRAINDICATIONS TO FIBRINOLYTIC THERAPY

Absolute contraindications

Risk of Intracranial haemorrhage

- Any history of intracranial haemorrhage
- Ischaemic stroke within 3 months
- Known structural cerebral vascular lesion (e.g. arteriovenous malformation)
- Known intracranial neoplasm

Risk of bleeding

- Active bleeding or bleeding diathesis (excluding menses)
- Significant head trauma within 3 months
- Suspected aortic dissection

Relative contraindications

Risk of intracranial haemorrhage

- Severe uncontrolled hypertension on presentation (BP > 180/110 mm Hg)*
- Ischaemic stroke more than 3 months ago
- History of chronic, severe uncontrolled hypertension

Risk of Bleeding

- Current use of anticoagulation in therapeutic doses (INR > 2)
- Recent major surgery < 3 weeks
- Traumatic or prolonged CPR >10 minutes
- Recent internal bleeding (e.g. gastrointestinal or urinary tract haemorrhage) within 4 weeks
- Non-compressible vascular puncture
- Active peptic ulcer

Others

- Pregnancy
- Prior exposure (>5 days and within 12 months of first usage) to streptokinase (if planning to use same agent)

* The blood pressure should be reduced prior to institution of fibrinolytic therapy.

Adapted from : 2nd CPG STEMI 2007

APPENDIX II: CLASSIFICATION OF TIMI FLOW

GRADE	DESCRIPTION
0	Complete occlusion of the infarct related artery
1	Some penetration of contract material beyond the point of obstruction but without perfusion of the distal coronary bed
2	Perfusion of the entire infarct vessel into the distal but with delayed flow compared with a normal artery
3	Full perfusion of the infarct vessel with normal flow

The TIMI Study Group. The Thrombolysis in Myocardial Infarction (TIMI) trial. N Engl J Med. 1985; 312: 932–936.

APPENDIX III: CLASSIFICATION OF TIMI MYOCARDIAL PERFUSION GRADE(TMP)

TMP GRADE	DESCRIPTION
0	Failure of dye to enter the microvasculature. Either minimal or no ground-glass appearance ("blush") or opacification of the myocardium in the distribution of the culprit artery, indicating lack of tissue-level perfusion.
1	Dye slowly enters but fails to exit the microvasculature. There is the ground-glass appearance ("blush") or opacification of the myocardium in the distribution of the culprit lesion that fails to clear from the microvasculature, and dye staining is present on the next injection (~30 seconds between injections).
2	Delayed entry and exit of dye from the microvasculature. There is the ground-glass appearance ("blush") or opacification of the myocardium in the distribution of the culprit lesion that is strongly persistent at the end of the washout phase (ie, dye is strongly persistent after 3 cardiac cycles of the washout phase and either does not or only minimally diminishes in intensity during washout).
3	Normal entry and exit of dye from the microvasculature. There is the ground-glass appearance ("blush") or opacification of the myocardium in the distribution of the culprit lesion that clears normally and is either gone or only mildly/moderately persistent at the end of the washout phase (ie, dye is gone or is mildly/moderately persistent after 3 cardiac cycles of the washout phase and noticeably diminishes in intensity during the washout phase), similar to that in an uninvolved artery. Blush that is of only mild intensity throughout the washout phase but fades minimally is also classified as grade 3.

Gibson CM, Cannon CP, Murphy SA, et al, for the TIMI study group. Relationship of TIMI myocardial perfusion grade to mortality after administration of thrombolytic drugs. Circulation. 2000;101:125–130.

APPENDIX IV : CLASSIFICATION OF UNSTABLE ANGINA*

Severity	CLINICAL CIRCUMSTANCES		
	A Develops in Presence of Extracardiac Condition That Intensifies Myocardial Ischemia (Secondary UA)	B Develops in Absence of Extracardiac Condition (Primary UA)	C Develops Within 2 wk of MI (Postinfarction UA)
I—New onset of severe angina or accelerated angina; no rest pain	I A	IB	IC
II—Angina at rest within past month but not within preceding 48 h (angina at rest, subacute)	IIA	IIB	IIC
III—Angina at rest within 48 h (angina at rest, acute)	IIIA	IIIB-T_{neg} IIIB-T_{pos}	IIIC

UA : Unstable angina; T : Tropinins

**Hamm CW, Braunwald E. A classification of unstable angina revisited. Circulation. 2000 ;102 :118-22.*

APPENDIX V : TIMI RISK SCORE FOR UA/NSTEMI

TIMI Risk Score	All-Cause Mortality, New or Recurrent MI, or Severe Recurrent Ischemia Requiring Urgent Revascularization Through 14 d After Randomization, %
0-1	4.7
2	8.3
3	13.2
4	19.9
5	26.2
6-7	40.9

The TIMI risk score is determined by the sum of the presence of 7 variables at admission:
1 point is given for each of the following variables:

- Age 65 y or older
- At least 3 risk factors for CAD (family history of premature CAD, hypertension,elevated cholesterols, active smoker, diabetes)
- Known CAD (coronary stenosis of ≥ 50%)
- Use of aspirin in prior 7 days
- ST-segment deviation (≥0.5mm) on ECG
- At least 2 anginal episodes in prior 24 h
- Elevated serum cardiac biomarkers

Total Score = 7 points

Low Risk : ≤ 2 point
Moderate Risk: 3-4 points
High Risk : ≥5 points

Adapted from :

- *Antman EM, Cohen M, Bernink PJ, et al. The TIMI risk score for unstable angina/ non-ST elevation MI: a method for prognostication and therapeutic decision making. JAMA 2000; 284 : 835–42 .*
- *Sabatine MS, Morrow DA, Giugliano RP, et al. Implications of upstream glycoprotein IIb/IIIa inhibition and coronary artery stenting in the invasive management of unstable angina/non ST elevation myocardial infarction. A comparison of the Thrombolysis in Myocardial Infarction (TIMI) IIIB trial and the Treat angina with Aggrastat and determine Cost of Therapy with Invasive or Conservative Strategy (TACTICS)-TIMI 18 trial. Circulation 2004; 109 : 874-880.*

APPENDIX VI : CLASSIFICATION OF ANGINA SEVERITY

Classification of angina severity according to the Canadian Cardiovascular Society

Class	Level of symptoms
Class I	"Ordinary activity does not cause angina". Angina with strenuous or rapid or prolonged exertion only.
Class II	"Slight limitation of ordinary activity". Angina on walking or climbing stairs rapidly, walking uphill or exertion after meals, in cold weather, when under emotional stress, or only during the first few hours after awakening.
Class III	"Marked limitation of ordinary physical activity". Angina on walking one or two blocks* on the level or one flight of stairs at a normal pace under normal conditions.
Class IV	"Inability to carry out any physical activity without discomfort" or "angina at rest"

* Equivalent to 100-200 m

APPENDIX VII: RISK FACTOR GOALS IN PATIENTS WITH CAD

	RISK FACTOR GOALS IN PATIENTS WITH CAD
Smoking	Quit
Blood pressure	<130/80mmHg
Lipids LDL-C HDL-C TG	 < 2.6mmol/l* > 1.1 mmol/l (male), > 1.3 mmol/l (female) < 1.7 mmol/l
Diabetes Fasting blood sugar 2hr PP HbA1c	 < 6.1mmol/l < 7.8 mmol/l < 6.5%**

* the lower the better.
In clinical trials, plaque regression was seen when LDL-C was <1.8mmol/l.
In patients with progressive disease, one should aim for LDL-C <1.8mmol/l.

** in patients with significant co-morbidities and complex CAD, an alternative target of < 7% is acceptable

APPENDIX VIII : CALCULATION OF CREATININE CLEARANCE

$$\text{Estimated GFR (ml/min)} = \frac{(140\text{-age}) \times \text{weight}}{(0.814 \times S_{Cr}\ [\mu\text{mol/L}])} \quad \text{or} \quad \frac{1.2\ (140\text{-age})}{S_{Cr}\ [\mu\text{mol/L}]}$$

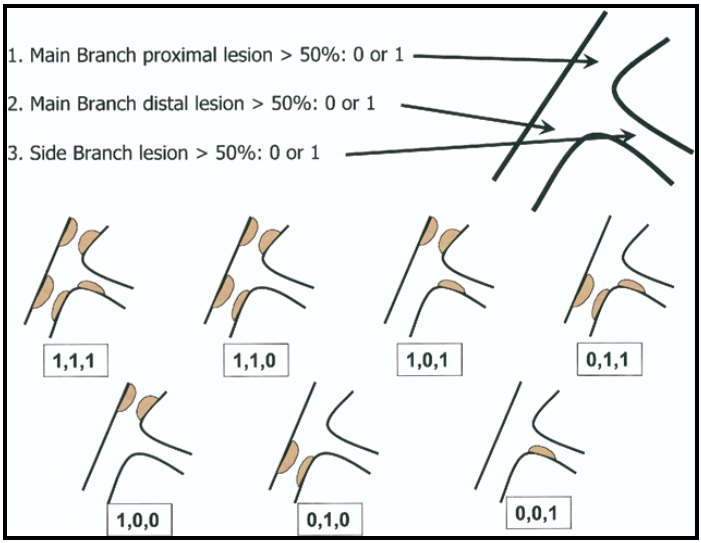
S_{Cr} : serum creatinine

Women: multiplication with 0.85

APPENDIX IX: COMMONLY USED IODINATED CONTRAST AGENTS

Compound	Name	Type	Iodine Content	Osmolality	Level
Ionic	Ioxaglate (Hexabrix)	Ionic Dimer	320	580	Low osmolar
Non-ionic	Iopamidol (Iopamaro 370)	Non-ionic monomer	370	796	Low osmolar
Non-ionic	Iohexol (Omnipaque 350)	Non-ionic	350	884	Low osmolar
Non -ionic	Iohexol (Omnipaque 300)	Non -ionic	300		Low osmolar
Non-ionic	Iodixanol (Visipaque 320)	Non-ionic Dimer	320	290	Iso osmolar

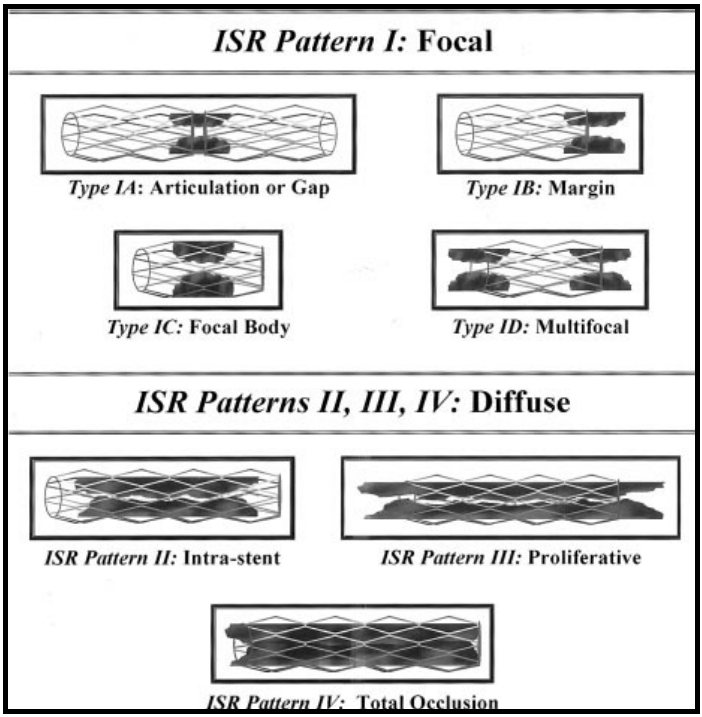
APPENDIX XI: MEDINA CLASSIFICATION OF BIFURCATION LESIONS



Adapted from Medina A, Suarez de Lezo J, Pan M. A new classification of coronary bifurcation lesions. Rev. Esp. Cardiol. 59(2), 183 (2006).

In the Medina classification a binary value (1,0) is given to each of the 3 components of a bifurcation (main branch proximal, main branch distal, and the side branch) according to whether each of these segments is compromised (1) or not (0).

APPENDIX XII: CLASSIFICATION OF INSTENT RESTENOSIS (ISR)



Adapted from Mehran R, Dangas G, Abizaid AS, et al. Angiographic Patterns of In-Stent Restenosis : Classification and Implications for Long-Term Outcome. Circulation 1999;100;1872-1878

Class I: Focal ISR group. Lesions are ≤10 mm in length and are positioned at the unscaffolded segment (ie, articulation or gap), the body of the stent, the proximal or distal margin (but not both), or a combination of these sites (multifocal ISR)

Class II: "Diffuse intrastent" ISR. Lesions are > 10 mm in length and are confined to the stent(s), without extending outside the margins of the stent(s).

Class III: "Diffuse proliferative" ISR. Lesions are >10 mm in length and extend beyond the margin(s) of the stent(s).

Class IV: ISR with "total occlusion." Lesions have a TIMI flow grade of 0.

APPENDIX XIII: GRADE OF RECOMMENDATION AND LEVEL OF EVIDENCE* FOR SECONDARY PREVENTION OF CAD

STRATEGY	GRADE OF RECOMMENDATION	LEVEL OF EVIDENCE	COMMENTS
Smoking Cessation	I	C	
Exercise	I	C	At least 30-60 min most days of the week
CONCOMITANT PHARMACOTHERAPY			
Aspirin	I	A	Maintenance dose: 75-150 mg daily
Clopidogrel	I	A	Maintenance dose 75 mg daily to be given for 1 month following PCI with BMS and for I year after DES implantation
Anti-coagulants (warfarin)	I	C	Long term therapy for patients in AF; 3-6 months for pts with mural thrombus
β-Blockers	I	A	Consider long term therapy for all patients if no contraindications
ACEI	I	A	Consider long term for all pts if no contraindications
ARB	I	B	For ACEI intolerant pts
Statins	I	A	Aim for an LDL-C <2.0mmol/l (the lower the better)

** ACC/AHA and ESC Classification*

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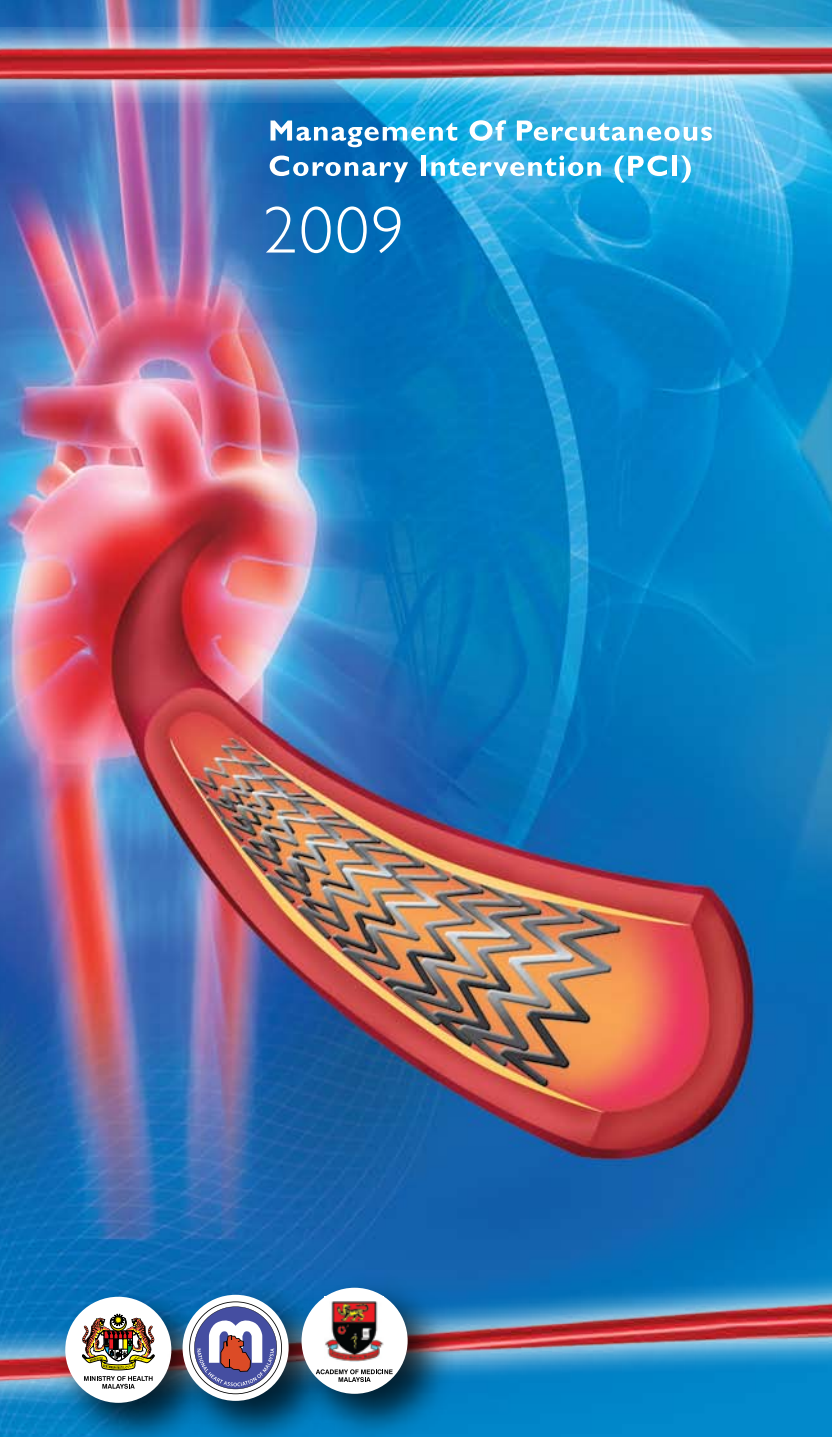
ABBREVIATIONS

aPTT: activated Partial Thromboplastin Time
atm: atmospheres
ACS: Acute Coronary Syndrome
ACE-I: Angiotensin Converting Enzyme Inhibitors
ARB: Angiotensin Receptor Blockers
ARC: Academic Research Consortium
ARF: Acute Renal Failure
A-V : Arterio-Venous
BMS: Bare Metal Stents
CABG: Coronary Artery Bypass Graft Surgery
CAD: Coronary Artery Disease
CART: Control Antegrade and Retrograde Techniques
CIN: Contrast Induced Nephropathy
CKD: Chronic Kidney Disease
CKMB: Creatine Kinase Myocardial Band
CT: Computed Tomogram
CTO: Chronic Total Occlusion
CVD: Cardiovascular Disease
DES: Drug Eluting Stents
ECG: Electrocardiogram
GFR: Glomerular Filtration Rate
GP: Glycoprotein
HIT: Heparin Induced Thrombocytopenia
HF: Heart Failure
IABP: Intra-Aortic Balloon Pump
IC: Intracoronary
IMA: Internal Mammary Artery
IU: International Units
IV: Intravenous
IRA: Infarct Related Artery
ISR: In-stent Restenosis
IVUS: Intravascular Ultrasound
LIMA: Left Internal Mammary Artery
LV: Left ventricle
LVEF: Left Ventricular Ejection Fraction
LVF: Left Ventricular Failure
LMWH: Low Molecualar Weight Heparin
LMS: Left Main Stem
LST: Late Stent Thrombosis
MECC: Medical Emergency Coordinating Center
MI: Myocardial Infarction
MLA: Minimum Luminal Area
NSTEMI: Non ST segment Elevation Myocardial Infarction
OTW: Over-the-wire
POBA: Plain Balloon Angioplasty
PCI: Percutaneous Coronary Intervention
PCWP: Pulmonary Capillary Wedge Pressure
ST: Stent Thrombosis
STEMI: ST segment Elevation Myocardial Infarction
SVG: Saphenous Vein Grafts
TIMI: Thrombolysis In Myocardial Infarction
TMP: TIMI Myocardial Perfusion grade
TLR: Target Lesion Revascularisation
TVR: Target Vessel Revascularisation
UA: Unstable Angina
UFH: Unfractionated Heparin
VLST: Very Late Stent Thrombosis

Management Of Percutaneous Coronary Intervention (PCI)

2009



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