1st Edition, 2015

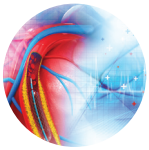
Appropriate Use Criteria for Investigations and Revascularization in CAD

National Heart Association of Malaysia

MINISTRY OF HEALTH MALAYSIA

Academy of Medicine Malaysia

Statement of Intent



This Appropriate Use Criteria (AUC) document has been developed as a supplement to the Clinical Practice Guidelines (CPG) on the Management of Stable Coronary Artery Disease (CAD), Management of Unstable Angina/Non ST Elevation Myocardial Infarction (UA/NSTEMI), Management of ST Elevation Myocardial Infarction (STEMI) and Percutaneous Coronary Intervention (PCI).[1-5] The recommendations of the CPGs are based on evidence that were current at the time of their writing and are the official recommendations of the Ministry of Health.

This AUC document aims to provide some guidance to healthcare providers on the appropriate use of medical diagnostic tests and treatment options in the management of patients with CAD. It combines the latest scientific evidence and the clinical judgement of a number of experts in utilizing these tests and treatment options in a variety of clinical scenarios that are encountered in daily practice. It is not a consensus statement. This AUC document also allows clinicians to measure their individual practice patterns and to make comparisons with their peers. It is however not a substitute to sound clinical judgement.

Period of validity
This AUC document was issued in 2015 and will be reviewed in 5 years or sooner as necessary.

Electronic version available on the following website:
http://www.moh.gov.my
http://www.acadamed.org.my
http://www.malaysianheart.org

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Appropriate Use Criteria
National Heart Association of Malaysia
Level 1, Heart House
Medical Academies of Malaysia
210, Jalan Tun Razak, 50400 Kuala Lumpur, Malaysia

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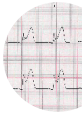

Message from the Director General of Health Malaysia

Cardiovascular Disease remains an important cause of mortality in Malaysia, accounting for 20-25% of all deaths in public hospitals. In Malaysia, patients with coronary artery disease (CAD) present at a mean age of 59 ± 12 years, 6 years younger than those in the Global Registry of Acute Coronary Events (GRACE). More importantly, Malaysian patients have high prevalence of cardiovascular risk factors.

The Ministry of Health (MOH) welcomes and supports the initiatives taken by National Heart Association of Malaysia (NHAM) to introduce the Appropriate Use Criteria (AUC) for management of CAD. This AUC document has been developed as a supplement to the Clinical Practice Guidelines (CPG) on the Management of Stable Coronary Artery Disease (CAD), Management of Unstable Angina/Non ST Elevation Myocardial Infarction (UA/NSTEMI), Management of ST Elevation Myocardial Infarction (STEMI) and Percutaneous Coronary Intervention (PCI). The development of this AUC aims to ensure that procedures are performed for appropriate indications, improve the physician's decision-making and educate patients on the expected benefits of the individual procedures. It combines the latest scientific evidence and the clinical judgement of a number of experts in utilizing tests and treatment options in a variety of clinical scenarios that are encountered in daily practice. Its rating is based on an average patient presenting to ***an average physician who would recommend or perform the procedure in an average hospital***.

I congratulate the panel and NHAM for the development and publication of this AUC on management of CAD. These efforts and contributions would definitely bring a great impact on the future management of cardiovascular disease in this nation. Last but not the least, I believe that the ultimate objective of any healthcare provider is not solely to save lives – but rather to save the future that one life can bring. Our goal is not restricted to the idea of restoring the physical capacity of our patients – but we hope to walk the extra mile for the patients' continuous, consistent, long-term well-being.

Datuk Dr. Noor Hisham Abdullah
Director General of Health Malaysia
Ministry of Health Malaysia

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Institut Jantung Negara
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YBhg. Tan Sri,

APPROPRIATE USE CRITERIA FOR CORONARY ARTERY DISEASE 2015 ENDORSEMENT

Merujuk kepada perkara yang tersebut di atas dan emel daripada pihak YBhg. Tan Sri bertarikh 11 Mac 2015 adalah berkaitan.

2. Pertama sekali Kementerian Kesihatan Malaysia (KKM) mengucapkan tahniah kepada *National Heart Association of Malaysia* di atas usaha untuk membangunkan kriteria yang bersesuaian dalam membuat ujian dan prosedur berkaitan jantung.

3. Sehubungan dengan itu, sukacita dimaklumkan bahawa pihak kementerian bersetuju menyokong permohonan ini serta penggunaan logo KKM oleh pihak jawatankuasa penulisan. Selain itu, pihak kami juga tiada halangan untuk dokumen tersebut dipaparkan di portal KKM untuk rujukan umum.

Sekian, terima kasih.

"BERKHIDMAT UNTUK NEGARA"

Yang ikhlas,

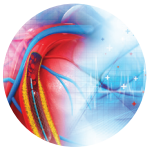
(DATUK DR. NOOR HISHAM ABDULLAH)

Message from the Representative of the American College of Cardiology

The efforts of the National Heart Association, in conjunction with Ministry of Health and the Academy of Medicine are most impressive. This comprehensive evaluation of appropriate use for testing and revascularization should serve as a guide and help to optimize cardiovascular care. The quality of this work and its timely delivery is nothing short of spectacular. The American College of Cardiology is proud of this "offspring", as perhaps only a parent can understand. Congratulations on a job well-done!

Robert C. Hendel,
MD, FACC, FAHA, FASNC
Chief, Cardiovascular Division (Interim)
University of Miami Miller School of Medicine
Service Chief, Cardiology
Director, Cardiac Care Unit
University of Miami Hospital

Members of the Writing Group



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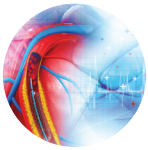
Rationale and Process of Document Development



The idea of an AUC originated in 2005 as a response to payers who were concerned of the escalation in healthcare costs from the increased utilization and the wide variation of practice in the usage of medical technology (echocardiography, radionuclide imaging, coronary computed tomography angiogram (CCTA) angiography and drug eluting stents) in the management of CAD. Since then, the objective of the AUC has evolved. The aim of the AUC is not to reduce or restrict the number of procedures that are performed but rather to ensure that they are used for appropriate indications. In this way, it aims to improve physician decision making and educate patients on the expected benefits of these individual procedures.

Process:

Step 1: Topic Selection and Writing Group Composition

This AUC was mooted by the National Heart Association of Malaysia (NHAM). The writing group was carefully chosen to include as many stakeholders as possible - interventional and non-interventional cardiologists, cardiac surgeons and general physicians from universities, private and public sectors. The methodology used was as outlined by the RAND/UCLA Manual and the American College of Cardiology Foundation.[6,7,8] In addition, the methods used by the European Society of Cardiology were also studied.[9]

Step 2: Literature Review and Development of Clinical Scenarios (Indications)

Firstly, a literature review was conducted to obtain current scientific evidence on the subject. Then, a list of clinical scenarios or "indications" was drawn up based on medical history and symptoms. For the clinical scenarios on revascularization, medical therapy, ischemic burden as indicated by non-invasive testing and coronary anatomy were included.

It is not possible to address all clinical scenarios that are encountered in daily clinical practice. Thus, the writing committee created common clinical scenarios encountered by most physicians/surgeons. High risk patients e.g. End Stage Renal Failure and patients who have combined CAD and valve disease were omitted.

There were some general assumptions made when the panelists were asked how they would manage the different scenarios (e.g. use of high quality machines giving reproducible and interpretable results, competent operators, etc). These and the terminology used in this document were clearly defined.

Step 3: Panel Rating of the Document

The document was then divided into 3 sections and 3 groups of experts were given the task of rating each section. These experts consisted of key opinion leaders from the public and private sectors and universities. An attempt was made to ensure that the rating panels were balanced (e.g. equal numbers of interventional cardiologists and cardiac surgeons and wherever applicable, a mixture of general cardiologists, emergency physicians and general physicians who were non-experts in the field being rated). They were given the latest scientific literature and the current CPGs on the topic being rated. Guidance on how to rate the document using the RAND method was also provided.

The panelists were asked to rate the appropriateness of each clinical scenario using their own best clinical judgement. They were specifically told to consider an **AVERAGE** patient presenting to an **AVERAGE** physician who performs the procedure in an **AVERAGE** hospital. It should not be based on unusual circumstances or indications. Although cost considerations is an important issue in deciding if the procedure or test is available, the panelists were specifically told not to consider costs in this exercise. The RAND method focuses on the initial question of whether the procedure or treatment option is effective and if the choice is reasonable considering the risk: benefit ratio. Cost issues are best discussed in consultation with payers, consumers and other policy makers.

The experts were first sent the clinical scenarios to find out if they had any modifications or new scenarios to add. They were also asked to forward their queries and uncertainties. The rating was done using a modified Delphi Method. The first rating was done by the panelists in their own workplace or home and then a face to face meeting was held. During this second meeting, after much discussion and agreement among the panel members, some of the clinical scenarios were altered to make them clearer and more relevant. A final rating occurred after this discussion.

In rating the clinical scenarios:

An **appropriate indication** is one in which the expected incremental information, combined with clinical judgement, exceeds the expected negative consequences by a sufficiently wide margin for a specific indication that the procedure is generally considered acceptable care and a reasonable approach for the indication.

Negative consequences include the risk of the procedure (radiation, contrast exposure) and the downstream impact of poor test performance such as delay in diagnosis (false negatives) or inappropriate diagnosis (false positives).

For each clinical scenario (or indication), each panelist is required to rate it from 1 to 9 depending on the benefit: harm ratio, a score of 1 meaning that the harm of the procedure/test outweighs its benefit and a rating of 9 means the benefit far outweighs the risk. A rating of 5 can mean either the benefit and harm are about equal or the panelist cannot make the judgement for the patient described in the clinical scenario.

Scoring is as follows:

Median score 7 to 9: Appropriate Care (A)

Benefits generally outweigh the risks; i.e. the procedure is generally acceptable and is generally reasonable for the indication.

Median Score 4 to 6: May be Appropriate Care (M)

At times, an appropriate option for the management of the patient due to ***variable evidence or agreement regarding the risk: benefit ratio***, the potential benefit based on practice experience in the absence of evidence. Effectiveness for the individual must be determined by the patient's physician in consultation with the patient based on additional clinical variables and judgement along with patient preferences i.e. the procedure may be acceptable and may be reasonable for the indication.

Median Score 1 to 3: <u>Rarely Appropriate Care (R)</u>

There is ***a lack of a clear benefit/risk advantage;*** rarely an effective option and exceptions should have documentation of the clinical reasons for proceeding with this care option. i.e. procedure is not generally acceptable and is not generally reasonable for the indication.

Step 4: Data Analysis

Only the results of the second round of rating were considered in the final analysis. The analysis was conducted using MS Excel 2010 using the formulas indicated in Supplement A.(pg 97)
The median panel rating for each clinical scenario was calculated.

- If the median was in the upper third -7,8,9 – the procedure was considered **Appropriate**. (i.e. A7, A8 or A9)
- If the median was in the middle third – 4,5,6- the procedure was considered as **May be Appropriate** (i.e. M6, M7 or M8)
- If the median fell in the lower third – 1,2,3 – then the procedure was considered **Rarely Appropriate**. (i.e. R1, R2 or R3)

If the Median fell in between the 3 point boundaries (i.e. 3.5 or 6.5) the committee decided to round away from the middle i.e. a 3.5 would become a 3 and a 6.5 will become 7 if there is Agreement. If there is Disagreement, then it would be rounded towards the middle i.e. a 3.5 to a 4 and a 6.5 to a 6.

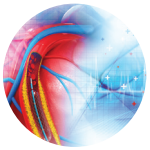
The numbers are a reflection of the continuum as per the appropriateness criteria methodology and should not be interpreted as "degrees of appropriateness or inappropriateness". It should not be confused with the Grades of Recommendation and Levels of Evidence used in the CPGs.

The dispersion of the panel ratings were taken as an indication of the level of agreement among the panel members. In addition, the 30th to 70th Interpercentile Range (IPR) and the Interpercentile Range Adjusted for Symmetry (IPRAS) were calculated for each scenario. (Supplement A, pg 97) If the IPR was greater than the IPRAS, it indicated Disagreement and if the IPRAS was greater than the IPR, then it indicated Agreement. If there was disagreement, then it was decided that the clinical scenario would be given a May Be Appropriate rating. In almost all cases where there was Disagreement, the median fell in that category and it was not necessary for the committee to alter the rating.

Step 5: Writing of the Document

The AUC document was then written up and circulated to the members of the Expert Panels and the Technical Committee, Ministry of Health, Malaysia for feedback. It was also sent to the Academy of Medicine and Director General of Health, Malaysia for feedback and endorsement.

Introduction



This Appropriate Use Criteria (AUC) has been developed to serve as a supplement to the Clinical Practice Guidelines (CPG).[1-5] It does not replace the CPGs which are evidence based. The objective of the AUC document is to combine the best available scientific evidence with the collective judgement of experts to produce a statement regarding the appropriateness of performing a procedure at the level of patient specific symptoms, medical history and test results. The aim is not to restrict the number of procedures being performed but to ensure that these are done appropriately based on current evidence.

Over the last few years, there has been an increase in the number and utilization of medical technology and devices in the diagnosis and treatment of patients with coronary artery disease (CAD). These newer technologies have benefited patients by improving their survival and quality of life but have put a strain on healthcare resources because of the escalating costs.

The objective of this AUC is to provide guidance for the optimal selection of patients in the utilization of these diagnostic tests and treatment options. It thus, endeavor to assist clinicians in decision making and improve patient education in the appropriate use of medical technology and devices available in the diagnosis and management of patients with CAD. It is not possible to cover all medical technology and devices and thus, we have restricted it to those devices that are easily available and commonly used in Malaysia e.g. Cardiac Magnetic Resonance Imaging (MRI) was not addressed because it is not widely available. It does not address the use of pharmaceutical agents which is already covered appropriately by the CPG.

The Multimodality AUC for the Diagnosis and Risk Assessment of Patients with Stable CAD (Section 1) was the most challenging because there are limited randomized controlled trials on the topic unlike the AUC on Coronary Revascularization (Section 2) for which there are a multitude of good quality trials to guide the recommendations.

This AUC is not however, a substitute for sound clinical judgement and experience.

This document is divided into 2 sections.

Section 1: Multimodality AUC for the Diagnosis and Risk Assessment of Patients with Stable CAD:

- 1.1 Definitions
- 1.2 General Assumptions
- 1.3 Clinical Scenarios

Section 2*:* AUC for Coronary Revascularization

- 2.1 ACUTE CORONARY SYNDROMES (ACS):
  - 2.1.1 ST Elevation Myocardial Infarction (STEMI)
  - 2.1.2 Unstable Angina/Non ST Elevation Myocardial Infarction (UA/NSTEMI)
- 2.2 Stable CAD
- 2.3 Mode of Revascularization
- 2.4 Ad Hoc Percutaneous Coronary Intervention (PCI)

SECTION 1:

MULTIMODALITY AUC FOR THE DIAGNOSIS AND RISK ASSESSMENT OF PATIENTS WITH STABLE CAD

Section 1: Multimodality AUC for the Diagnosis and Risk Assessment of Patients with Stable CAD:

- 1.1 Definitions
- 1.2 General Assumptions
- 1.3 Clinical Scenarios

Section 1

MULTIMODALITY AUC FOR THE DIAGNOSIS AND RISK ASSESSMENT OF PATIENTS WITH STABLE CAD

Expert Panel (in alphabetical order)

Both 1st and 2nd Rating

Dr. Alan Fong	*Consultant Cardiologist, Hospital Umum Sarawak, Kuching*
Dr. Aris Chandran	*Consultant Physician, Hospital Raja Permaisuri Bainun, Ipoh*
Dr. Choo Gim Hooi	*Consultant Cardiologist, Subang Jaya Medical Center, Petaling Jaya*
Dr. David Chew	*Consultant Cardiologist, National Heart Institute, Kuala Lumpur*
Dr. Dewi Ramasamy	*Consultant Cardiologist, Gleneagles Kuala Lumpur, Kuala Lumpur*
Dr. Jeswant Dillon	*Consultant Cardiothoracic Surgeon, National Heart Institute, Kuala Lumpur*
Dr. Lee Chuey Yan	*Consultant Cardiologist, Hospital Sultanah Aminah, Johor Bahru*
Dr. Mohd Rahal Yusoff	*Specialist in Internal Medicine, Hospital Kuala Lumpur, Kuala Lumpur*
Dr. Mohd Zamrin Dimon	*Consultant Cardiothoracic Surgeon, University Technology Mara, Sungai Buloh*
Dr. Ong Mei Lin	*Consultant Cardiologist, Gleneagles Penang, Penang*
Dr. Sree Raman K	*Consultant Physician, Hospital Tuanku Jaafar, Seremban*
Dr. Zurkurnai Yusof	*Consultant Cardiologist, Hospital Universiti Sains Malaysia, Kota Bharu*

1st Rating only

Dr. Suren Thuraisingham	*Consultant Cardiologist, Sunway Medical Centre, Petaling Jaya*

Summary

Rating Category	Median Score	Definition
Appropriate Care (A)	**7 - 9**	**Benefits generally outweigh the risks;** i.e. the procedure is generally acceptable and is generally reasonable for the indication.
May be Appropriate Care (M)	**4 - 6**	At times an appropriate option for the management of the patient due to **variable evidence or agreement regarding the risk: benefit ratio,** the potential benefit based on practice experience in the absence of evidence.
Rarely Appropriate Care (R)	**1 - 3**	There is **a lack of a clear benefit/risk advantage;** rarely an effective option and exceptions should have documentation of the clinical reasons for proceeding with this care option.

The scores are a reflection of the continuum as per the appropriateness criteria methodology and should not be confused with the Grades of Recommendation and Levels of Evidence used in the CPGs.

The Expert Panel rated the scenarios considering an **AVERAGE** patient presenting to an **AVERAGE** physician who performs the procedure in an **AVERAGE** hospital. This AUC aims to combine the best available scientific evidence with the collective judgement of experts.

The Final Decision of which investigation(s) (if any) is to be done and the further management of each patient will depend on the patient's preference guided by the clinician.

Patients with Stable CAD

A) Detection of CAD or Risk Assessment in Symptomatic patients without known CAD

- Patients without known CAD but presenting with symptoms suggestive of CAD should have their pre-test probability of disease first determined (Table 1, pg 29). This will help guide the appropriate investigation.

Patients who can exercise and with interpretable resting ECG:

- the ***Appropriate*** investigation is an Exercise ECG in **all** probability subsets and Stress ECHO in **Intermediate and High Risk** patients.

Patients who cannot exercise and/or have uninterpretable resting ECG:

- the ***Appropriate*** investigation is a stress ECHO or an MPI in **all** probability subsets.
- CCTA is an ***Appropriate*** investigation in symptomatic **Intermediate and High Risk** individuals.
- Inv CA is an **Appropriate** investigation in symptomatic **High Risk** individuals.

MPI: myocardial perfusion Imaging (radionuclide Imaging); CCTA: Computed Coronary Tomography Angiography; Inv CA: Invasive Coronary Angiography

B) Detection of CAD or Risk assessment in Asymptomatic patients without known CAD

- Asymptomatic patients should have their Global Risk Score (FRS) determined prior to test selection. (Appendix I, pg 83)

Patients who can exercise and with interpretable resting ECG:

- Exercise ECG is ***Appropriate*** in **all** population subsets
- In **Intermediate to High Risk** patients, Stress ECHO is an ***Appropriate*** investigative tool
- In **High Risk** Individuals, MPI and CCTA ***May Be Appropriate***

Patients who cannot exercise and/or with un-interpretable resting ECG:

- Exercise ECG is ***Rarely Appropriate*** in this setting
- Stress ECHO is ***Appropriate*** in **all** patient subsets
- In **High Risk** patients, MPI and CCTA are ***Appropriate***

Family History of premature CAD

- In patients with **Low CAD Risk**, Exercise ECG is ***Appropriate***
- In patients with **Intermediate to High CAD Risk**, Exercise ECG and Stress ECHO are ***Appropriate*** and MPI, CCTA and Inv CA ***May Be Appropriate***.

MPI: myocardial perfusion Imaging (radionuclide Imaging); CCTA: Computed Coronary Tomography Angiography; Inv CA: Invasive Coronary Angiography

C) Detection of CAD in other clinical scenarios

New onset Heart Failure (HF) and no prior CAD

- In patients with **HF due to reduced LV function**, stress ECHO and MPI are ***Appropriate*** modalities to detect the presence of CAD. These imaging modalities can detect hibernating and infarcted myocardium. Inv CA is also ***Appropriate***.
- Exercise ECG (if the patient can exercise and is in New York Functional Class I or II) and CCTA ***May Be Appropriate*** investigations.
- In patients with **HF due to preserved LV function**, Exercise ECG, Stress ECHO and MPI are all ***Appropriate*** investigations. Occasionally CCTA and Inv CA ***May Be Appropriate***.

Arrhythmias

In the presence of:

- New onset Atrial Fibrillation(AF), MPI and Inv CA ***May Be Appropriate***. The other modalities are ***Rarely Appropriate.***
- Non sustained Ventricular Tachycardia (VT) or Frequent Premature Ventricular Contractions (PVC's), Exercise ECG is ***Appropriate*** and the other investigations ***May Be Appropriate.***
- Sustained VT or Resuscitated Sudden Cardiac Death, Inv CA is ***Appropriate***. The other tests are ***Rarely Appropriate.***

Syncope

In patients at:

- **Low CAD Risk**, Exercise ECG ***May Be Appropriate*** and the other tests are ***Rarely Appropriate.***
- **Intermediate and High CAD Risk**, Exercise ECG is ***Appropriate*** and the other modalities ***May Be Appropriate.***

Coronary evaluation before non-coronary cardiac surgery

In patients at:

- **Low CAD Risk**, Exercise ECG, Stress ECHO and MPI ***May Be Appropriate.***
- **Intermediate and High CAD Risk**, CCTA and Inv CA are ***Appropriate*** and the other investigations are ***Rarely Appropriate***.

MPI: myocardial perfusion Imaging (radionuclide Imaging); CCTA: Computed Coronary Tomography Angiography; Inv CA: Invasive Coronary Angiography

D) Preoperative evaluation for non-cardiac surgery in a patient without active cardiac conditions

Low Risk surgery
(risk of death or MI < 1% e.g. cataract, simple plastic surgery)

- Cardiac investigations are ***Rarely Appropriate*** irrespective of functional capacity.

Intermediate Risk and High Risk surgery
(risk of death or MI ≥ 1% e.g. intra peritoneal, intra thoracic)

In patients:

- with no clinical risk predictors[#] and exercise capacity ≥ 4 METS[##], investigations for CAD are ***Rarely Appropriate.***
- with functional capacity < 4 METS[##] with 1 or more clinical risk predictors[#], stress ECHO is ***Appropriate*** and Exercise ECG, MPI and CCTA ***May Be Appropriate.***
- who are asymptomatic < 1 year following a normal Inv CA, stress test or a coronary revascularization procedure, cardiac investigations are ***Rarely Appropriate.***

Vascular surgery/Liver and Kidney transplant

In patients:

- with functional capacity ≥ 4 METS, Exercise ECG, Stress ECHO and MPI are ***Appropriate*** and CCTA and Inv CA ***May Be Appropriate.***
- with functional capacity < 4 METS stress ECHO, MPI and CCTA are ***Appropriate*** and Inv CA ***May Be Appropriate.***
- who are asymptomatic < 1 year following a normal Inv CA, stress test or a coronary revascularization procedure, cardiac investigations are ***Rarely Appropriate.***

 # Clinical Risk Predictors are: CAD, Heart Failure, Cardiomyopathy, Valvular Heart Disease, Arrhythmias and Pulmonary Vascular Disease[14]

4 METS is equivalent to doing housework, vacuuming and sweeping floors (Appendix III, pg 85-86)

MPI: myocardial perfusion Imaging (radionuclide Imaging); CCTA: Computed Coronary Tomography Angiography; Inv CA: Invasive Coronary Angiography

E) Routine or periodic testing for Cardiac risk assessment in the Asymptomatic and Stable Patient

Normal Prior Exercise ECG

- If the patient is at **Intermediate to High CAD Risk** and his last exercise ECG is > 2 years, it is ***Appropriate*** to repeat the stress ECG and Stress ECHO.
- It is ***Rarely Appropriate*** to perform a repeat cardiac assessment if the patient had a normal Exercise ECG test < 2 years ago.

Abnormal Prior Exercise ECG

- This group would include patients who either had false positive prior Exercise ECG or had test results that were abnormal at high workloads (Appendix IV, pg 87) and were continued on Optimum Medical Therapy (OMT).
- If the last test was < 2 years, then a stress ECHO or CCTA ***May Be Appropriate*** investigations and MPI or Inv CA are ***Rarely Appropriate***.
- If the last test was > 2 years, then a repeat Exercise ECG and Stress ECHO would be ***Appropriate*** and MPI, CCTA and Inv CA ***May Be Appropriate***.

Normal Prior Stress Imaging

- An Exercise ECG and a repeat stress ECHO are ***Appropriate*** in a patient at **Intermediate to High CAD risk** if the last test was done > 2 years ago. MPI and CCTA ***May Be Appropriate***.
- In a patient with **Low CAD Risk**, a repeat cardiac investigation is ***Rarely Appropriate***.

E) Routine or periodic testing for Cardiac risk assessment in the Asymptomatic and Stable Patient *(con't)*

Prior Coronary Calcium Score < 2 years ago

If the calcium score was:

- 0, repeat cardiac assessment is ***Rarely Appropriate***
- < 100, then an exercise ECG ***May Be Appropriate*** and other cardiac investigations are ***Rarely Appropriate***.
- 100-400 and the patient is **Low to Intermediate CAD risk** then an Exercise ECG is Appropriate and stress ECHO, MPI and CCTA ***May Be Appropriate*** investigations and Inv CA is ***Rarely Appropriate***. If the patient is at **High CAD risk**, then Exercise ECG and Stress ECHO are ***Appropriate*** and MPI, CCTA and Inv CA ***May Be Appropriate***.
- > 400 then Exercise ECG and Stress ECHO are ***Appropriate*** and MPI and Inv CA ***May Be Appropriate***.

Obstructive CAD in Prior CCTA or Inv CA

- This group would include patients who were advised OMT rather than revascularization.
- If the last test was < 2 years, Exercise ECG or stress ECHO are ***Appropriate*** and an Inv CA ***May Be Appropriate***.
- If the last test was > 2 years, Exercise ECG, stress ECHO and MPI are ***Appropriate*** and an Inv CA ***May Be Appropriate***.

Non obstructive CAD in Prior CCTA or Inv CA

- The only ***Appropriate*** investigation is to repeat the Exercise ECG if the CCTA or Inv CA was performed > 2 years ago. A Stress ECHO ***May Be Appropriate*** in this same situation.
- A repeat cardiac assessment within 2 years is ***Rarely Appropriate***.

F) Cardiac risk assessment in the presence of new onset or worsening symptoms

Prior Exercise ECG

If previously:

- abnormal, an Inv CA is ***Appropriate*** and Stress ECHO, MPI and CCTA ***May Be Appropriate***. It is ***Rarely Appropriate*** to repeat the Exercise ECG.
- normal, then a repeat Exercise ECG or Stress ECHO are ***Appropriate.***

Prior stress imaging study

- If previously normal, then Exercise ECG, Stress ECHO and MPI are ***Appropriate.***

Prior Coronary Calcium Score

- > 100 Agatston score –Exercise ECG, Stress ECHO, MPI and Inv CA are all ***Appropriate.***

Obstructive CAD in Prior CCTA or Inv CA

- Inv CA is ***Appropriate.***
- Exercise ECG, Stress ECHO, MPI and CCTA ***May Be Appropriate.***

MPI: myocardial perfusion Imaging (radionuclide Imaging); CCTA: Computed Coronary Tomography Angiography; Inv CA: Invasive Coronary Angiography

G) Risk Assessment post-revascularization

Suspected ischemic symptoms:

- It is ***Appropriate*** to consider Exercise ECG, stress ECHO and MPI. CCTA and Inv CA ***May Be Appropriate.***

Asymptomatic

In the presence of:

- incomplete revascularization post PCI - Exercise ECG, Stress ECHO and MPI are ***Appropriate.***
- prior Left main PCI- Exercise ECG is ***Appropriate*** and stress ECHO, MPI, CCTA and Inv CA ***May Be Appropriate.***
- < 5 years post CABG-Exercise ECG and Stress ECHO ***May Be Appropriate*** and CCTA and Inv CA are ***Rarely Appropriate.***
- ≥ 5 years post CABG- Exercise ECG is ***Appropriate*** and Stress ECHO, MPI and CCTA ***May Be Appropriate.***
- < 2 years post PCI- Cardiac Investigations are ***Rarely Appropriate.***
- ≥ 2 years post PCI- Exercise ECG, Stress ECHO and MPI ***May Be Appropriate*** and CCTA and Inv CA are ***Rarely Appropriate.***

MPI: myocardial perfusion Imaging (radionuclide Imaging); CCTA: Computed Coronary Tomography Angiography; Inv CA: Invasive Coronary Angiography

Patients undergoing cardiac assessment may be:

- Asymptomatic
- Not known to have CAD but now having chest pains/chest pain equivalents
- Known to have CAD

When ordering an investigation, one must, firstly, consider the issue that is being assessed. In some individuals, especially in those with known CAD, the issue is the presence of ischemia and if present, the extent of the ischemic burden, to help guide the need for revascularization in addition to continuing optimal medical therapy (OMT). Physiological tests such as stress ECG, stress ECHO and myocardial perfusion imaging studies may be the more appropriate investigations.

Other tests e.g. CT or invasive coronary angiogram provide anatomical data and can detect CAD with high certainty. These tests are however, not appropriate for everyone because of the inherent risks and costs of the procedure (e.g. radiation, exposure to contrast etc). Thus, the risk: benefit ratio should be taken into account when ordering an investigation.

The objective of this AUC is to determine the appropriateness of each investigation for the clinical scenario being presented.

1.1 DEFINITIONS

1.1.1 Chest pain/discomfort or angina equivalent may be classified as[10]:

- Typical angina (definite):
  - Substernal chest pain, or an ischemic equivalent discomfort that is:
    - Provoked by exertion or emotional stress, and
    - Relieved by rest and/or nitroglycerin
- Atypical angina (probable):
  - Chest pain or discomfort with two characteristics of definite or typical angina
- Non-anginal chest pain:
  - Chest pain or discomfort that meets one or none of the typical angina characteristics

Patients with stable CAD have had symptoms for longer than 2 months[11].

1.1.2 Pre-test Probability

Patients with no previous CAD but now presenting with chest pain/chest discomfort should have their pre-test probability of CAD determined prior to non-invasive testing. Various algorithms can be applied, including that in Table 1, pg 29.[12,13]

Based on this algorithm, the definition for:

- 'Low pre-test probability' is having a < 10% pre-test probability of CAD
- 'Intermediate pre-test probability' is having a 10-90% pre-test probability of CAD
- 'High pre-test probability' is having a > 90% pre-test probability of CAD.

Table 1: Pre-test Probability of CAD by Age, Sex and Symptoms.[12,13]

Age years	Gender	Typical angina	Atypical Angina	Non-anginal	Asymptomatic
< 39	Male	Inter-mediate	Inter-mediate	Low	Very Low
	Female	Inter-mediate	Very Low	Very Low	Very Low
40-49	Male	High	Inter-mediate	Inter-mediate	Low
	Female	Inter-mediate	Low	Very Low	Very Low
50-59	Male	High	Inter-mediate	Inter-mediate	Low
	Female	Inter-mediate	Inter-mediate	Low	Very Low
> 60	Male	High	Inter-mediate	Inter-mediate	Low
	Female	High	Inter-mediate	Inter-mediate	Low

1.1.3 Global CAD Risk

Asymptomatic patients without CAD should be risk stratified prior to being subjected to cardiac investigations. (Appendix I, pg 83) There are many such risk equations available and that using locally available data is the most suitable for any given population. Until such local data is available, we recommend the Framingham Risk Score (FRS). This estimates the risk of "hard" CAD events i.e. cardiac death and nonfatal myocardial infarction over the next 10 years. Based on the FRS, an asymptomatic person can be at:

- **Low CAD Risk:** 10 year CAD risk < 10%
- **Intermediate CAD Risk:** 10 year CAD risk 10-20%
- **High CAD Risk:** 10 year risk > 20%
- **CAD Equivalents** which includes other clinical forms of atherosclerotic disease (atherosclerosis in any vascular bed - aorta including abdominal aortic aneurysm, carotid, cerebral and peripheral vessels) and type 2 Diabetes mellitus (T2DM)

1.1.4 Un-interpretable ECG

This refers to ECG with resting ST segment depression (> 0.10 mV), left bundle branch block (LBBB), pre–excitation, paced rhythm or digoxin use that would make the stress ECG difficult to interpret.

The modalities that are available for the diagnosis and risk assessment of CAD and which will be discussed in this AUC document are:

- Exercise ECG.
- Stress Echocardiogram (ECHO) – could be either treadmill or pharmacological stress testing.
- Myocardial Perfusion Imaging (MPI-radionuclide imaging) -could be either treadmill or pharmacological stress testing.
- Computed Coronary Tomography Angiogram- CCTA (also called non-invasive coronary angiogram or heart-scan) - This does **NOT** include calcium scoring.
- Invasive coronary angiogram-Inv CA.

Each of these tests vary in their sensitivity and specificity in detecting CAD (Appendix II, pg 84). Some of these are functional tests of ischemia while others show the coronary anatomy and not the functional significance of the lesion. The most appropriate investigative tool for the diagnosis and risk assessment of any one individual with or suspected to have CAD will depend on the:

- clinical condition of the patient and the pre-test probability of disease.
- global CAD risk if the patient is asymptomatic.
- local availability of the diagnostic modality.
- associated risks due to ionizing radiation, contrast exposure – this risk will vary depending on the patient.
- cost constraints.

1.2 General Assumptions

- The diagnostic modality is performed and interpreted by adequately trained personnel.
- The diagnostic modality is available.
- The patient is asymptomatic or has stable CAD.
- The patient's ECG is interpretable unless otherwise stated.
- Exercise testing is assumed to be treadmill exercise for patients that can exercise. The patient should be able to exercise to achieve at least > 85% of the maximal heart rate for age or till he develops symptoms.
- Routine testing implies that a test is repeated because a period of time has elapsed and not because there is a change in the clinical condition of the patient or there is a need to consider changing therapy.
- Each modality of testing has its own inherent risks- e.g. radiation, contrast sensitivity, bodily injury and interpretation error. This risk : benefit ratio should be considered in the rating process.

1.3 Clinical Scenarios

These include:

A) Detection of CAD or Risk Assessment in Symptomatic patients Without known CAD.

B) Detection of CAD or Risk assessment in Asymptomatic patients Without known CAD.

C) Detection of CAD in patients in other clinical scenarios.

D) Preoperative evaluation for non-cardiac surgery in a patient without active cardiac conditions.

E) Routine or periodic testing for Cardiac risk assessment in the Asymptomatic and Stable Patient.

F) Cardiac risk assessment in the presence of new onset or worsening symptoms.

G) Risk Assessment post-revascularization.

A) Detection of CAD or Risk Assessment in Symptomatic patients without known CAD

Pre-test Probability	Clinical Scenario	Exercise ECG	Stress ECHO	MPI*	CCTA**	Inv CA***
Low	ECG interpretable **AND** able to exercise	A8	M6	R3	R2	R1
	ECG uninterpretable **OR** unable to exercise	R1.5	A7.5	A7	M5.5	R2
Inter-mediate	ECG interpretable **AND** able to exercise	A9	A7	M5.5	M5	R3
	ECG uninterpretable **OR** unable to exercise	R3	A8	A7	A7	M4
High	ECG interpretable **AND** able to exercise	A8.5	A7	A7	M5.5	A7
	ECG uninterpretable **OR** unable to exercise	R2	A8	A8	A7	A7

**MPI: myocardial perfusion Imaging (radionuclide Imaging); **CCTA: Computed Coronary Tomography Angiography; ***Inv CA: Invasive Coronary Angiography*

The numbers are a reflection of the continuum as per the appropriateness criteria methodology and should not be confused with the Grades of Recommendation and Levels of Evidence used in the CPGs.

B) Detection of CAD or Risk assessment in Asymptomatic patients without known CAD

CAD Risk Score	Clinical Scenario	Exercise ECG	Stress ECHO	MPI*	CCTA**	Inv CA***
Low (FRS < 10%)	ECG interpretable **AND** able to exercise	**A7**	**M4**	**R2**	**R2**	**R1**
	ECG uninterpretable AND/**OR** unable to exercise	**R2**	**A7**	**R3**	**R2.5**	**R1**
Inter-mediate (FRS 10-20%)	ECG interpretable **AND** able to exercise	**A7.5**	**A7**	**R3**	**R3**	**R2**
	ECG uninterpretable AND/**OR** unable to exercise	**R2**	**A7.5**	**M5**	**M4**	**R2.5**
High (FRS > 20% or CAD equivalents)	ECG interpretable **AND** able to exercise	**A8**	**A7**	**M5.5**	**M5.5**	**R3**
	ECG uninterpretable AND/**OR** unable to exercise	**R2**	**A8**	**A7**	**A7**	**M4.5**
Family History of premature CAD	ECG interpretable **AND** able to exercise	**A7**	**M5.5**	**R3**	**M4**	**R1.5**
	ECG uninterpretable AND/**OR** unable to exercise	**A7.5**	**A7**	**M6**	**M6**	**M4**

**MPI: myocardial perfusion Imaging (radionuclide Imaging); **CCTA: Computed Coronary Tomography Angiography; ***Inv CA: Invasive Coronary Angiography*

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C) Detection of CAD in other clinical scenarios

Clinical Scenario		Exercise ECG	Stress ECHO	MPI*	CCTA**	Inv CA***
New onset Heart Failure and no prior CAD	LV systolic failure (LVEF < 40%)	**M6**	**A7**	**A7**	**M6**	**A7**
	Preserved LV function (LVEF > 50%)	**A7**	**A7**	**A7**	**M5.5**	**M5.5**
Arrhythmias	New onset AF	**R2**	**R2.5**	**M5**	**R2**	**M6**
	Non sustained VT or frequent PVC	**A7**	**M5**	**M6**	**M4.5**	**M5.5**
	Sustained VT or resuscitated SCD	**R2.5**	**R2.5**	**M5**	**M6**	**A9**
Syncope	Low CAD risk	**M5.5**	**R3**	**R3**	**R3**	**R1**
	Intermediate to High CAD risk	**A7**	**M5**	**M5**	**M5**	**M5**
Coronary evaluation before non-coronary cardiac surgery	Low CAD risk	**M6**	**M5**	**M4**	**R3**	**R2**
	Intermediate to High CAD risk	**R2**	**R2**	**R2**	**M7**	**M8**

**MPI: myocardial perfusion Imaging (radionuclide Imaging); **CCTA: Computed Coronary Tomography Angiography; ***Inv CA: Invasive Coronary Angiography*

The numbers are a reflection of the continuum as per the appropriateness criteria methodology and should not be confused with the Grades of Recommendation and Levels of Evidence used in the CPGs.

D) Preoperative evaluation for non-cardiac surgery in a patient without active cardiac conditions

Clinical Scenario		Exercise ECG	Stress ECHO	MPI*	CCTA**	Inv CA***
Low Risk surgery (risk of death or MI < 1%[14] e.g. cataract, simple plastic surgery)	Irrespective of functional capacity	**R2**	**R2**	**R2**	**R2**	**R1**
Inter-mediate risk and High Risk surgery (risk of death or MI > 1%[14] e.g. intra peritoneal, intra thoracic)	No clinical risk predictors#	**R3**	**R3**	**R3**	**R3**	**R1**
	Functional capacity ≥ 4 METS##	**R3**	**R3**	**R2.5**	**R2.5**	**R1**
	Functional capacity < 4 METS with 1 or more clinical risk predictors#	**M5**	**A7**	**M5**	**M4**	**R3**
	Asymptomatic < 1 year following a normal Inv CA, stress test or a coronary revascularization	**R2**	**R2**	**R2**	**R1.5**	**R1**
Vascular surgery/ Liver and Kidney transplant	Functional capacity ≥ 4 METS	**A7**	**A7**	**A7**	**M5**	**M4.5**
	Functional capacity < 4 METS	**M4**	**A8**	**A7**	**A7**	**M5.5**
	Asymptomatic < 1 year following a normal Inv CA, stress test or a coronary revascularization	**R3**	**R3**	**R3**	**R2.5**	**R1.5**

 # Clinical Risk Predictors are: CAD, Heart Failure, Cardiomyopathy, Valvular Heart Disease, Arrhythmias and Pulmonary Vascular Disease[14]

4 METS is equivalent to doing housework, vacuuming and sweeping floors (Appendix III, page 85-86)

**MPI: myocardial perfusion Imaging (radionuclide Imaging); **CCTA: Computed Coronary Tomography Angiography; ***Inv CA: Invasive Coronary Angiography*

The numbers are a reflection of the continuum as per the appropriateness criteria methodology and should not be confused with the Grades of Recommendation and Levels of Evidence used in the CPGs.

E) Routine or periodic testing for Cardiac risk assessment in the Asymptomatic and Stable Patient

Clinical Scenario			Exercise ECG	Stress ECHO	MPI*	CCTA**	Inv CA***
Prior Exercise ECG	Abnormal	Last test < 2 years	R3	M4.5	R2	M4	R2.5
		Last test ≥ 2 years	A7	A7	M4.5	M4.5	M4.5
	Normal	Low CAD risk	R2	R2	R1.5	R1	R1
		Intermediate to High CAD Risk < 2 years	R3	R3	R2	R2	R2
		Intermediate to High CAD Risk ≥ 2 years	A7.5	A7	R3	R2.5	R3
Prior stress imaging study	Normal	Low CAD risk	R2.5	R2	R1	R1	R1
		Intermediate to High CAD Risk < 2 years	M4	R3	R2.5	R2.5	R2
		Intermediate to High CAD Risk ≥ 2 years	A7	A7	M5.5	M5.5	R3
Prior Coronary Calcium Score < 2 years ago	Calcium score 0		R1.5	R1.5	R1.5	R1	R1
	< 100 Agatston score		M5	R3	R3	R2.5	R2
	100-400 Agatston score **AND** low to intermediate CAD risk		A7	M6	M4	M4.5	R3
	100-400 Agatston score **AND** High CAD Risk		A8	A7	M5.5	M5	M4.5
	> 400 Agatston score		A8	A7	M6	R3	M5
Obstructive CAD in Prior CCTA or Inv CA	Last test < 2 years		A8	A7.5	M5.5	R3	M4
	Last test ≥ 2 years		A8	A8	A7	M4.5	M5
Non obstructive CAD in Prior CCTA or Inv CA	Last test < 2 years		R2	R2	R2	R1	R1
	Last test ≥ 2 years		A7	M6	R3	R2	R1

**MPI: myocardial perfusion Imaging (radionuclide Imaging); **CCTA: Computed Coronary Tomography Angiography; ***Inv CA: Invasive Coronary Angiography*

The numbers are a reflection of the continuum as per the appropriateness criteria methodology and should not be confused with the Grades of Recommendation and Levels of Evidence used in the CPGs.

F) Cardiac risk assessment in the presence of new onset or worsening symptoms

Clinical Scenario		Exercise ECG	Stress ECHO	MPI*	CCTA**	Inv CA***
Prior Exercise ECG	Normal	**A8**	**A7**	**A7**	**M6**	**M6**
	Abnormal	**R3**	**M5**	**M5.5**	**M6**	**A8.5**
Prior stress imaging study	Normal	**A8.5**	**A7.5**	**A7**	**M6**	**M5**
Prior Coronary Calcium Score	> 100 Agatston score	**A7.5**	**A8**	**A7**	**M6**	**A7**
Obstructive CAD in Prior CCTA or Inv CA		**M5**	**M5.5**	**M5.5**	**M5**	**A8**

**MPI: myocardial perfusion Imaging (radionuclide Imaging); **CCTA: Computed Coronary Tomography Angiography; ***Inv CA: Invasive Coronary Angiography*

The numbers are a reflection of the continuum as per the appropriateness criteria methodology and should not be confused with the Grades of Recommendation and Levels of Evidence used in the CPGs.

G) Risk Assessment post-revascularization

Clinical Scenario		Exercise ECG	Stress ECHO	MPI*	CCTA**	Inv CA***
Presence of suspected Ischemic Symptoms		**A8**	**A8**	**A7**	**M6**	**M6**
Asymptomatic	Incomplete revascularization, post PCI	**A7**	**A7.5**	**A7**	**R3**	**R3**
	Prior Left main PCI	**A7**	**M5.5**	**M6**	**M6**	**M6**
	< 5 years post CABG	**M4**	**M4**	**R3**	**R3**	**R2**
	≥ 5 years post CABG	**A7.5**	**M6**	**M5.5**	**M5.5**	**R3**
	< 2 years post PCI	**R3**	**R3**	**R3**	**R2**	**R2**
	≥ 2 years post PCI	**M6**	**M6**	**M5**	**R3**	**R2.5**

**MPI: myocardial perfusion Imaging (radionuclide Imaging); **CCTA: Computed Coronary Tomography Angiography; ***Inv CA: Invasive Coronary Angiography*

The numbers are a reflection of the continuum as per the appropriateness criteria methodology and should not be confused with the Grades of Recommendation and Levels of Evidence used in the CPGs.

SECTION 2:

AUC FOR CORONARY REVASCULARIZATION

Section 2: AUC for Coronary Revascularization

- 2.1 ACUTE CORONARY SYNDROMES (ACS):
  - 2.1.1 ST Elevation Myocardial Infarction (STEMI)
  - 2.1.2 Unstable Angina/ Non ST Elevation Myocardial Infarction (UA/NSTEMI)
- 2.2 Stable CAD
- 2.3 Mode of Revascularization
- 2.4 Ad Hoc Percutaneous Coronary Intervention (PCI)

Expert Panel (in alphabetical order)

AUC for Coronary Revascularization In ST Elevation Myocardial Infarction (STEMI)

Both 1st and 2nd Rating

Dr. Azani Md Daud — *Consultant Cardiologist, Gleneagles Kuala Lumpur, Kuala Lumpur*

Dr. Lam Kai Huat — *Consultant Cardiologist, Assunta Hospital, Petaling Jaya*

Dr. Liew Houng Bang — *Consultant Cardiologist, Hospital Queen Elizabeth II, Kota Kinabalu*

Dr. Mahathar Abd Wahab — *Consultant Emergency Physician, Hospital Kuala Lumpur, Kuala Lumpur*

Dr. Mohd Rahal Yusoff — *Specialist in Internal Medicine, Hospital Kuala Lumpur, Kuala Lumpur*

Dr. Omar Ismail — *Consultant Cardiologist, Hospital Pulau Pinang, Penang*

Dr. Pau Kiew Kong — *Consultant Cardiothoracic Surgeon, National Heart Institute, Kuala Lumpur*

Dr. Rashidi Ahmad — *Consultant Emergency Physician, Universiti Malaya Medical Centre, Kuala Lumpur*

Dr. Sree Raman K — *Consultant Physician, Hospital Tuanku Jaafar, Seremban*

Dr. Wan Azman Wan Ahmad — *Consultant Cardiologist, Universiti Malaya Medical Centre, Kuala Lumpur*

1st Rating only

Dr. GR Letchuman — *Consultant Physician, Hospital Taiping*

Dr. Oteh Maskon — *Consultant Cardiologist, UKM Medical Centre, Kuala Lumpur*

Dr. Saravanan K — *Consultant Cardiologist, Hospital Pulau Pinang, Penang*

Expert Panel (in alphabetical order)

AUC for Coronary Revascularization In Unstable Angina/Non ST Elevation Myocardial Infarction (UA/NSTEMI), Stable CAD. AUC for Mode of Revascularization & Ad Hoc PCI

Both 1st and 2nd Rating

Dr. Abdul Latif Mohamed — *Consultant Cardiologist, Cyberjaya Univ College of Medical Sciences, Cyberjaya*

Dr. Abdul Muiz Jasid — *Consultant Cardiothoracic Surgeon, Hospital Serdang, Serdang*

Dr. Azani Md Daud — *Consultant Cardiologist, Gleneagles Kuala Lumpur, Kuala Lumpur*

Dr. Azhari Yakub — *Consultant Cardiothoracic Surgeon, National Heart Institute, Kuala Lumpur*

Dr. David Quek Kwang Leng — *Consultant Cardiologist, Pantai Hospital, Kuala Lumpur*

Dr. David Tang Tiek Yew — *Consultant Cardiothoracic Surgeon, Hospital QE2, Kota Kinabalu*

Dr. John Chan Kok Meng — *Consultant Cardiothoracic Surgeon, Hospital Umum Sarawak, Kuching*

Dr. Kannan Pasamanickam — *Consultant Cardiologist, Subang Jaya Medical Centre, Petaling Jaya*

Dr. Mohd Hamzah Kamarulzaman — *Consultant Cardiothoracic Surgeon, Hospital Pulau Pinang, Penang*

Dr. Omar Ismail — *Consultant Cardiologist, Hospital Pulau Pinang, Penang*

Both 1st and 2nd Rating

Dr. Ong Tiong Kiam	*Consultant Cardiologist, Hospital Umum Sarawak, Kuching*
Dr. Ng Wai Kiat	*Consultant Cardiologist, Pantai Hospital, Kuala Lumpur*
Dr. Pau Kiew Kong	*Consultant Cardiothoracic Surgeon, National Heart Institute, Kuala Lumpur*
Dr. Raja Amin Raja Mokhtar	*Consultant Cardiothoracic Surgeon, Universiti Malaya Medical Centre, Kuala Lumpur*
Dr. Rosli Mohd Ali	*Consultant Cardiologist, National Heart Institute, Kuala Lumpur*
Dr. Sazzli Kasim	*Consultant Cardiologist, University Technology Mara, Sungai Buloh*
Dr. Venugopal Balchand	*Consultant Cardiothoracic Surgeon, Pantai Hospital, Kuala Lumpur*

1st Rating only

Dr Abdul Rashid A. Rahman	*Consultant Physician An-Nur Specialist Hospital, Bandar Baru Bangi*
Dr. Simon Lo	*Consultant Cardiologist, Gleneagles Penang, Penang*

Summary

Rating Category	Median Score	Definition
Appropriate Care (A)	**7 - 9**	**Benefits generally outweigh the risks;** i.e. the procedure is generally acceptable and is generally reasonable for the indication.
May be Appropriate Care (M)	**4 - 6**	At times an appropriate option for the management of the patient due to **variable evidence or agreement regarding the risk: benefit ratio,** the potential benefit based on practice experience in the absence of evidence.
Rarely Appropriate Care (R)	**1 - 3**	There is **a lack of a clear benefit/risk advantage;** rarely an effective option and exceptions should have documentation of the clinical reasons for proceeding with this care option.

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The Final Decision of which investigation(s) (if any) is to be done and the further management of each patient will depend on the patient's preference guided by the clinician.

2.1 AUC for Coronary Revascularization in STEMI

A) Primary PCI for patients with STEMI presenting at a PCI Capable Centre (Flowchart 1, pg 48)

It is *Appropriate* to consider Primary PCI in patients presenting:

- < 12 hours of ischemic symptom onset
- < 3 hours of ischemic symptom onset and PCI time delay is < 60 minutes and DBT < 90 minutes
- < 3 hours of ischemic symptom onset and PCI time delay is > 60 minutes and the DBT 90 - ≤ 120minutes
- 3 - < 12 hours of ischemic symptom onset and the DBT < 90 minutes
- with high risk features and < 12 hours of ischemic symptom onset
- with contraindications to fibrinolytic therapy and PCI can be performed within 12 hours of symptom onset (preferably as soon as possible)

It *May be Appropriate* to consider Primary PCI in patients presenting:

- 3 - <12 hours of ischemic symptom onset and PCI time delay is > 60 minutes and DBT 90 - ≤ 120 minutes

DBT: *Door to Balloon time;*
***PCI Time Delay**: Door to Balloon time – Door to Needle Time)*

B) Primary PCI for patients with STEMI presenting at a Non PCI capable Centre (Flowchart 2, pg 49)

It is *Appropriate* to consider Transfer for Primary PCI in patients presenting < 12 hours of ischemic symptom onset:

- who have contraindications to fibrinolytic therapy or complications such as cardiogenic shock and acute HF and are fit to transfer and Primary PCI can be performed within 120 minutes
- who have been administered fibrinolytic therapy and then transferred for PCI within 3-24 hours post fibrinolysis as part of a pharmaco-invasive strategy

C) PCI for patients with STEMI presenting > 12 - < 24 hours of ischemic symptom onset

It is *Appropriate* to consider Primary PCI in patients presenting > 12 - < 24 hours of ischemic symptom onset:

- who have evidence of on-going ischemia, heart failure or hemodynamic and/or electrical instability

D) Revascularization > 24 hours of ischemic symptom onset post fibrinolysis or those who did not receive fibrinolysis (Flowchart 3, pg 50-51)

It is *Appropriate* to consider revascularization in patients > 24 hours of ischemic symptom onset with:

- evidence of failed reperfusion or re-occlusion,
- cardiogenic shock or acute HF that develops after initial presentation
- spontaneous or easily provoked myocardial ischemia
- intermediate or high risk findings on pre-discharge stress ECG (Appendix IV, pg 87)

It is *Rarely Appropriate* to consider revascularization in patients > 24 hours of ischemic symptom onset:

- with no demonstrable ischemia by symptoms and on pre-discharge non-invasive ischemia testing

E) Other PCI strategies in STEMI (Flowchart 3, pg 50-51)

It is *Appropriate* to consider revascularization in STEMI patients in the following situations:

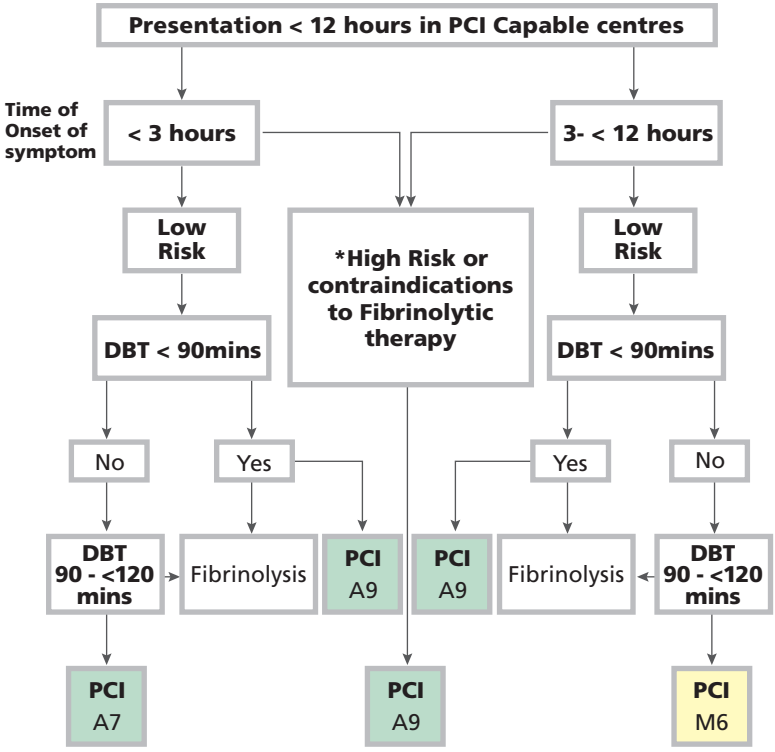
- Rescue PCI initiated very early (within 1-2 hours) for failed reperfusion in a PCI capable centre and a Non PCI capable centre
- spontaneous or inducible ischemia on non-invasive testing

It is *Rarely Appropriate* to consider revascularization in STEMI patients in the following situations:

- no demonstrable ischemia on non-invasive testing
- PCI of totally occluded arteries 3-28 days post STEMI as part of a routine strategy

Flowchart 1:

Patients presenting < 12 hours of symptom onset at a PCI capable centre

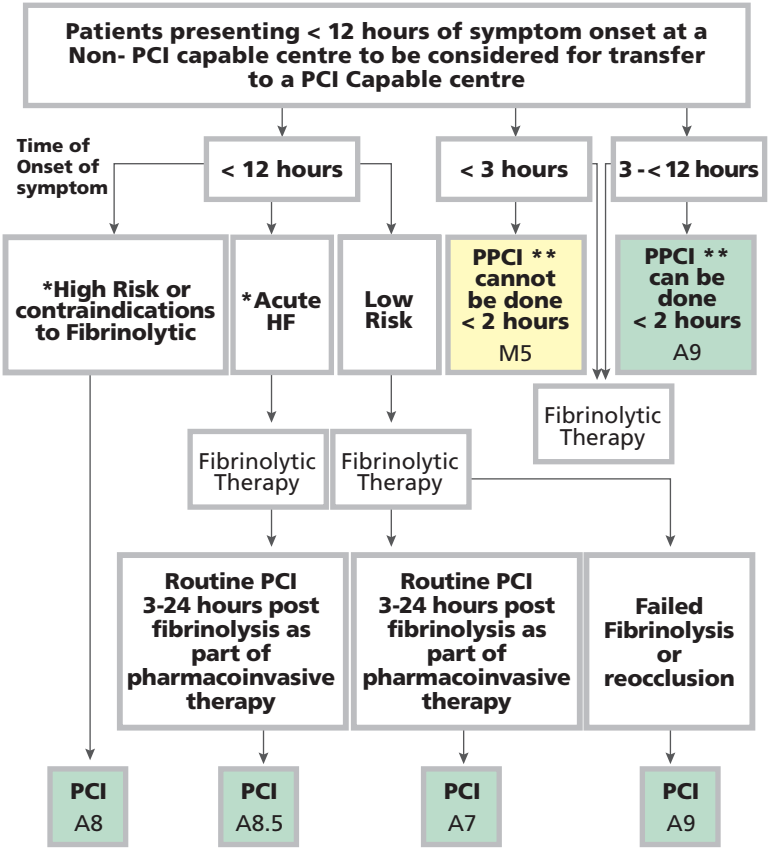


** High Risk is indicated by large infarct, anterior infarct, hypotension, cardiogenic shock, significant arrhythmias, elderly patients, post revascularization, previous infarction and heart failure*

The numbers are a reflection of the continuum as per the appropriateness criteria methodology and should not be confused with the Grades of Recommendation and Levels of Evidence used in the CPGs.

Flowchart 2:

Patients presenting < 12 hours of symptom onset at a non PCI capable centre and being considered for transfer for PCI

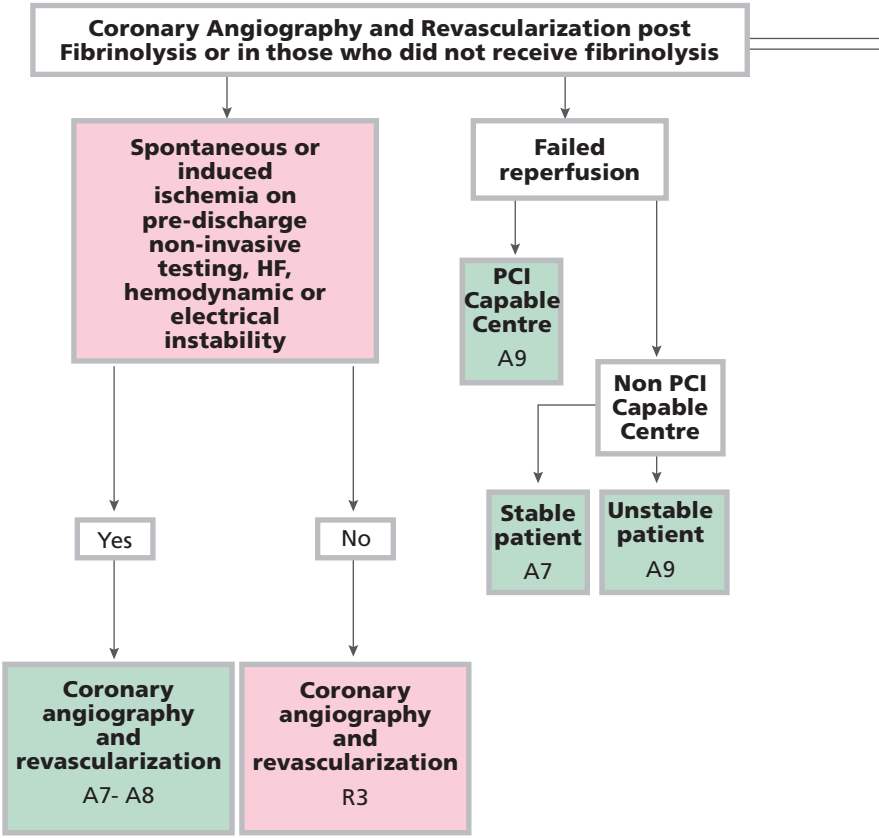


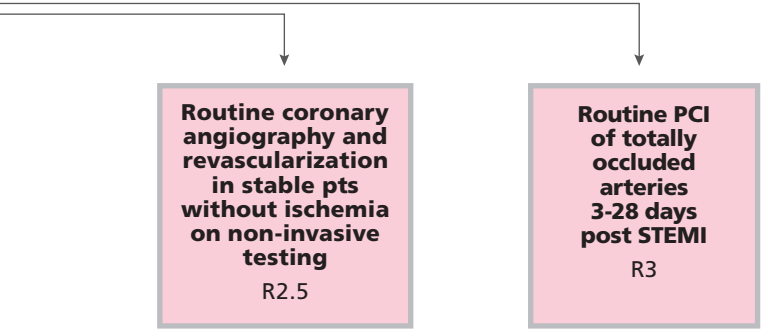
** Cardiogenic Shock or Acute Heart Failure and fit to transfer*
*** PPCI – Primary PCI*

The numbers are a reflection of the continuum as per the appropriateness criteria methodology and should not be confused with the Grades of Recommendation and Levels of Evidence used in the CPGs.

Flowchart 3:

Coronary Angiography and Revascularization > 24 hours after symptom onset post fibrinolysis or in those who did not receive fibrinolysis




Routine coronary angiography and revascularization in stable pts without ischemia on non-invasive testing
R2.5
Routine PCI of totally occluded arteries 3-28 days post STEMI
R3

2.2 AUC for Coronary Revascularization in UA/NSTEMI

Coronary Revascularization in UA/NSTEMI (Flowchart 4, pg 54-55)

It is *Appropriate* to consider revascularization in patients with:

- refractory angina and/or hemodynamic instability due to ischemia
- recurrent myocardial ischemia in-hospital
- moderate to high risk features after initial medical stabilization
- abnormal stress testing with moderate to high risk features (Appendix IV, pg 87) after initial medical stabilization
- who are still symptomatic after medical stabilization with OMT if the stenosis of the culprit artery is:
  - > 70%
  - stenosis 50-70% and FFR < 0.8

It is *Rarely Appropriate* to consider revascularization of the culprit vessel if the stenosis < 50%

2.3 AUC for Coronary Revascularization in Stable CAD

AUC for Coronary Angiography in Stable CAD

- It is ***Appropriate*** **to consider coronary angiography** in patients with moderate to severe angina (CCS class III-IV, Appendix V, pg 88)
- It is ***Rarely Appropriate*** **to consider coronary angiography** in patients with no symptoms and ischemia absent or present only at high work-loads on non-invasive testing

Coronary Revascularization in patients with stable CAD

- All patients should be on OMT which includes lifestyle changes, antiplatelet agents, ß-blockers, statins and at least 2 different classes of anti-angina medications at maximal tolerated doses at least 2 weeks before revascularization

It is *Appropriate* to consider revascularization in patients with:

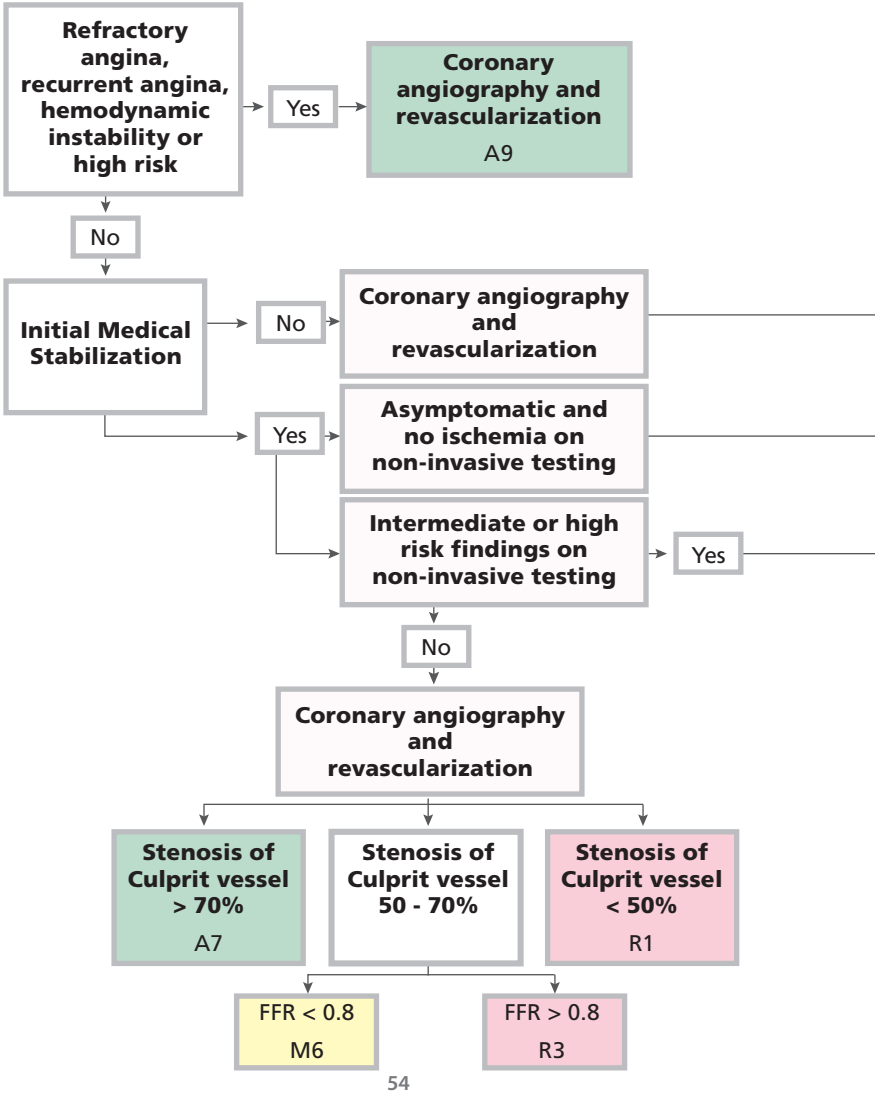
- Left main stenosis > 50%
- Any number of vessels with stenosis > 70% irrespective of Left Ventricular Ejection Fraction (LVEF)
- Refractory symptoms in the presence of coronary stenosis > 70%
- Large area of ischemia (> 10% of Left Ventricle)
- Single remaining patent coronary artery with > 50% stenosis

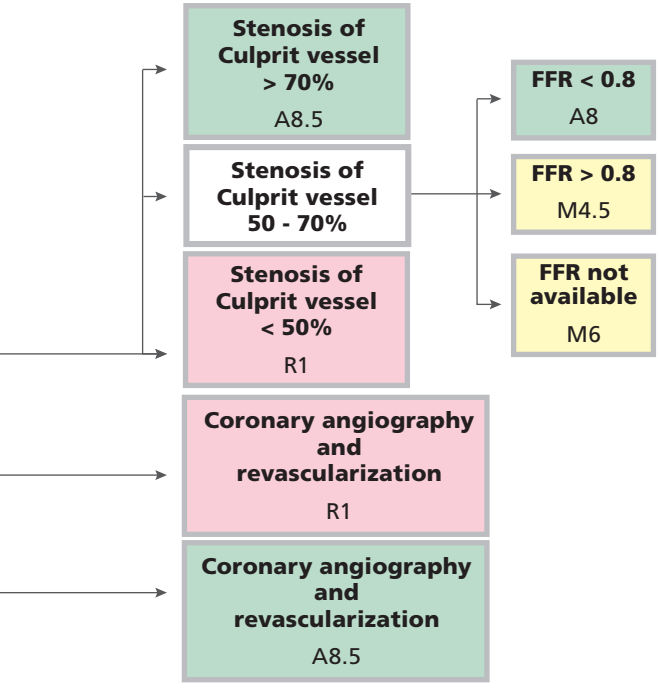
It is *Rarely Appropriate* to consider revascularization in:

- patients with 1 vessel CAD with stenosis < 50%, normal LVEF, and no ischemia detected by non-invasive tests and/or FFR > 0.8

Flowchart 4:

Revascularization in Patients with UA/NSTEMI




Stenosis of Culprit vessel > 70%
A8.5
Stenosis of Culprit vessel 50 - 70%
Stenosis of Culprit vessel < 50%
R1
FFR < 0.8
A8
FFR > 0.8
M4.5
FFR not available
M6
Coronary angiography and revascularization
R1
Coronary angiography and revascularization
A8.5

2.4 AUC for Mode of Revascularization in UA/NSTEMI after medical stabilization and Stable CAD

Mode of Revascularization in UA/NSTEMI after initial medical stabilization and Stable CAD

- All patients should be on OMT which includes lifestyle changes, antiplatelet agents, ß-blockers, statins and at least 2 different classes of anti-angina medications at maximal tolerated doses for at least 2 weeks before revascularization.

CABG is the *Appropriate* mode of revascularization in patients with:

- Left main stenosis and additional intermediate to high CAD burden (*Syntax score > 22) irrespective of diabetic status
- Left main stenosis and additional low CAD burden (*Syntax score < 22) irrespective of diabetic status
- Isolated Left main stenosis (ostial and/or body) irrespective of diabetic status
- Triple vessel disease with intermediate to high CAD burden (*Syntax score > 22) irrespective of diabetic status

Both CABG and PCI are *Appropriate* modes of revascularization in patients with:

- Isolated Left main stenosis (ostial and/or body) with no diabetes
- Triple vessel disease with low CAD burden (*Syntax score < 22) irrespective of diabetic status
- Two vessel disease with Proximal Left Anterior Descending Artery (LAD) involvement irrespective of diabetic status

Mode of Revascularization in UA/NSTEMI after initial medical stabilization and Stable CAD *(con't)*

PCI is the *Appropriate* mode of revascularization in patients with:

- Two vessel disease without Proximal LAD involvement irrespective of diabetic status
- Single vessel disease with symptoms and ischemia despite OMT with and without Proximal LAD involvement irrespective of diabetic status

Where a decision is made to perform a procedure that is considered Rarely Appropriate or May be Appropriate, the Heart Team or at least a second cardiology opinion should be sought and the reasons carefully documented in the patient's medical records.

**Syntax score[25] - Appendix VIII, pg 92*

2.5 AUC for Ad Hoc PCI

Ad Hoc PCI

All patients should:

- be on OMT which includes lifestyle changes, antiplatelet agents, ß-blockers, statins and at least 2 different classes of anti-angina medications at maximal tolerated doses for at least 2 weeks before revascularization.
- have given informed consent prior to sedation
- have been explained the possible outcomes and the potential treatment options prior to the coronary angiography

Ad Hoc PCI is considered *Appropriate* in:

- STEMI - PPCI of the Infarct related Artery
- UA/NSTEMI- Revascularization of culprit artery or multiple arteries if culprit cannot be clearly determined in patients with refractory angina, recurrent ischemia and/or hemodynamic instability due to ischemia
- STABLE CAD - Patients on OMT and target lesion(s) are consistent with non-invasive testing and/or FFR < 0.8 and who are not considered appropriate for CABG as in the criteria listed in section 2.4

Ad Hoc PCI is considered *Rarely Appropriate* in:

- patients with no symptoms and non-invasive testing for ischemia has not been performed and facilities for FFR is not available on site
- Left main or complex triple vessel disease

There has been considerable progress in the management of CAD – both stable disease and ACS. Advances in guide wire, balloon and stent technology have made it technically feasible to treat most coronary stenosis by percutaneous coronary intervention (PCI) while the use of arterial conduits and better surgical handling techniques have resulted in longer term patency of grafts, post Coronary Artery Bypass Grafting (CABG). Advances in anesthetic techniques, better myocardial protection and post-operative care have also made most elective CABGs safe operations with low operative mortality and morbidity.

There is an inherent difference between these 2 modes of myocardial revascularization – PCI treats only the targeted local coronary lesion and leaves adjacent areas of at-risk vulnerable myocardium alone, whereas CABG, by bypassing the entire at-risk area of myocardium, treats both the local coronary lesion and the adjacent segments. Thus following PCI, a patient is more likely to develop symptoms and ischemia due to progressive disease than following CABG.[15-20]

At the same time as there have been developments in interventional and surgical techniques, optimum medical therapy (OMT-which includes intensive lifestyle changes and pharmacotherapy) has been shown in many well designed clinical trials to result in comparable long term survival as revascularization procedures (PCI and CABG) in selected stable patients.[21-22]

Most coronary lesions, especially in patients with stable CAD, can be treated effectively by either OMT alone or in combination with PCI and/or CABG. The most appropriate management of any one patient at any particular point of time will depend on:

- the acuteness of the clinical presentation (ACS versus stable CAD)
- the availability of local resources and the expertise of the operators
- the presence and extent of myocardial ischemia as indicated by symptoms, non-invasive testing and/or fractional flow reserve
- the coronary anatomy
- current evidence from well conducted clinical trials on the potential benefits of each mode of treatment
- the risks associated with each invasive procedure- this risk may change with time and with the clinical condition of the patient
- social and cultural factors and importantly
- the wishes of the patient

Ideally the existence of a "Heart Team" consisting of cardiologists, cardiac surgeons and where necessary, other physicians such as general physicians, nephrologists, neurologists and anesthesiologists help provide a balanced decision making process for each individual patient.[23,24] Consensus on the optimal management should then be documented. In practice, this may sometimes be difficult to achieve. Standard protocols may be used to avoid the need for systematic case-by-case review of all diagnostic angiograms.

2 a) General Assumptions

Assumptions were made and considered in rating the relevant clinical indications for AUC for reperfusion/revascularization. These include:

- Patients fulfilled the criteria for STEMI, UA/NSTEMI or stable CAD
- In making the rating, each patient's clinical status, ischemic burden as assessed by non-invasive testing and the coronary anatomy is considered.
- Based on coronary angiographic findings, a significant coronary stenosis for the purpose of these clinical scenarios is defined as:
    - Greater than or equal to 70% luminal diameter narrowing, by QCA , of an epicardial coronary artery as measured in the "worst view" angiographic projection
    - Greater than or equal to 50% luminal diameter narrowing, by QCA, of the left main coronary artery as measured in the "worst view" angiographic projection
    - A " borderline" coronary lesion has a luminal diameter of 50-70%, by QCA, as measured in the "worst view" angiographic projection
- All patients with ACS should receive standard care as outlined in the CPGs which includes aspirin, (and clopidogrel *or* prasugrel *or* ticagrelor), ß-blockers, Angiotensin Converting Enzyme Inhibitors (ACE-I)/Angiotensin Receptor Blockers (ARB) and high potency statins.
- The PCI is done by experienced operators in well-equipped centres

- Primary PCI is done by operators who have done sufficient number of procedures.
- In STEMI, the door to balloon time (DBT) < 90 minutes and PCI time delay < 60 minutes [i.e. DBT minus (-) Door to Needle time (DNT) < 60 minutes]
- The fibrinolytic therapy given is either streptokinase or preferably a fibrin selective agent such as tenecteplase and is administered with a DNT< 30 minutes
- Patients with stable CAD should be on OMT which includes anti-platelet agents, ß-blocker, ACE-I/ARB, statins and where necessary, nitrates. Adequate anti- angina therapy is defined as at least 2 classes of medications to reduce angina at the maximal tolerated doses for at least 2 weeks.
- Patients with stable CAD should have non-invasive testing for ischemic burden prior to coronary angiography. Non-invasive tests include stress ECG, Stress imaging, MPI or cardiac MRI. If non-invasive testing has not been done, then facilities to measure fractional flow reserve (FFR) should be available.
- Reperfusion in STEMI is by PPCI or fibrinolytic therapy.
- Revascularization for UA/NSTEMI after medical stabilization and stable CAD is by PCI or CABG. The mode of revascularization would depend on the Syntax score (Appendix VIII, pg 92), the STS score[26] and EuroSCORE II.[27] For the purpose of this AUC, the patient is considered to be low to moderate surgical risk.
- No unusual circumstances exist (such as inability to comply with antiplatelet agents, do not resuscitate status, patient unwilling to consider revascularization, technically not feasible to perform revascularization, or comorbidities likely to markedly increase procedural risk substantially)

SECTION 2.1 ACUTE CORONARY SYNDROMES (ACS)

ACS is a clinical spectrum of ischemic heart disease. Depending upon the degree and acuteness of coronary occlusion, it can range from Unstable Angina (UA), Non-ST elevation myocardial infarction (NSTEMI) to ST elevation myocardial infarction (STEMI).

2.1.1 STEMI

2.1.1 a) Definition:

- **STEMI:** The diagnosis is made by the presence of myocardial injury or necrosis as indicated by a rise and fall of serum cardiac biomarkers. In addition there should be at least one of the following:[28]
    - Clinical history consistent with chest pain of ischemic origin.
    - ECG changes of ST segment elevation or presumed new LBBB.
    - Imaging evidence of new loss of viable myocardium or new regional wall motion abnormality.
    - Identification of an intracoronary (IC) thrombus by angiography or autopsy.

- FMC – First medical contact. In theory it is supposed to be the first medic/paramedic the patient seeks help from. For the purpose of this document we refer to the first medic/paramedic the patient sees at the Casualty of the first hospital he goes to.
- Stable patient – in the setting of ACS, it refers to a patient who no longer has ischemic type chest pains, shortness of breath and has a stable blood pressure (BP) and heart rhythm.
- Unstable patient – in the setting of ACS – it refers to a patient who continues to have persistent or recurrent ischemic type chest pains and/or heart failure and/or arrhythmias and/or a low BP.
- Spontaneous ischemia refers to a patient having ischemic type chest discomfort at rest, with or without provocation. (e.g. while sleeping or after eating)

2.1.1 b) AUC for PCI in STEMI

The goal of therapy is to open the occluded infarct related artery (IRA) as quickly as possible to salvage myocardium, preserve Left Ventricular (LV) function and improve short and long term survival. Primary PCI (PPCI) is the preferred reperfusion strategy in patients with ischemic symptoms < 12 hours if it can be done in a timely manner. The choice of strategy (fibrinolytic therapy or PPCI) depends on whether the patient with STEMI:

- presents at a PCI capable centre or at a non PCI capable centre
- the time of onset of symptoms prior to presentation
- time of transfer to a PCI capable centre
- availability of resources

When both reperfusion strategies are available, the following factors are important considerations in deciding the reperfusion strategy of choice:

- Time from symptom onset to first medical contact (FMC)
- Time to PCI (time from hospital arrival to balloon dilatation i.e. door to balloon time -DBT).
- Time to hospital fibrinolysis (time from hospital arrival to administration of fibrinolytic therapy i.e. door to needle time -DNT).
- Contraindications to fibrinolytic therapy
- High-risk patients

The time intervals mentioned are evidenced based and derived from the large mega trials conducted in patients with STEMI as well as from meta-analysis.

Primary PCI is the reperfusion therapy of choice in STEMI. The purpose of this AUC is to determine the appropriateness of PPCI versus the administration of fibrinolytic therapy if PCI cannot be performed with a DBT< 90 minutes taking into consideration the clinical status of the patient and other clinical scenarios (e.g. high risk STEMI, presence of contraindications to fibrinolytic therapy, etc). It also aims to determine the role of PCI in other settings in a patient with STEMI.

A) Patients presenting < 12 hours of symptom onset at a PCI Capable centre

	PPCI in STEMI < 12 hours of symptom onset at a PCI capable centre	Appropriate Use Criteria (1-9)
1	PPCI in patients presenting **< 12 hours** of ischemic symptom onset	**A8**
2	PPCI in patients presenting **< 3 hours** of ischemic symptom onset and **PCI time delay is < 60 minutes** and **DBT < 90 minutes**	**A9**
3	PPCI in patients presenting **< 3 hours** of ischemic symptom onset and **PCI time delay is > 60 minutes** and **DBT > 90 minutes < 120 minutes**	**A7**
4	PPCI in patients presenting **3-12 hours** of ischemic symptom onset and the **DBT < 90 minutes**	**A9**
5	PPCI in patients presenting **3-12 hours** of ischemic symptom onset and the **DBT > 90 minutes < 120 minutes**	**M6**
6	PPCI in **high risk patients presenting < 12 hours** of ischemic symptom onset as indicated by large infarcts, anterior infarct, hypotension, cardiogenic shock, significant arrhythmias, elderly patients, post revascularization, previous myocardial infarction and presence of heart failure	**A9**
7	PPCI in patients who have **contraindications to fibrinolytic therapy** and PCI can be performed within 12 hours of symptom onset	**A9**

B) Patients presenting < 12 hours of symptom onset at a Non-PCI capable centre

The transfer for PCI may be considered in the following clinical conditions or scenarios.

	Patients presenting < 12 hours of symptom onset at a Non-PCI capable centre to be considered for transfer to a PCI capable centre	Appropriate Use Criteria (1-9)
1	Onset of ischemic symptoms < 12 hours and fibrinolytic therapy is **contraindicated** irrespective of time delay from FMC	A8
2	**Cardiogenic shock** and **fit for transfer*** irrespective of time delay	A8
3	**Acute Heart Failure** and **fit for transfer***	A8
4	**Acute Heart Failure** - to administer fibrinolytic therapy if tolerated and transfer the patient for a **pharmacoinvasive** strategy within 3-24 hours post fibrinolysis	A8.5
5	Onset of ischemic symptoms between **3 and 12 hours** and PPCI (including transfer to a PCI centre) can be **performed within 2 hours** (preferably as soon as possible)	A9
6	**Low risk patients** presenting **< 3 hours** of symptom onset	M5
7	**Failed fibrinolytic** therapy as indicated by ongoing chest pain, persistent hyperacute changes or < 50% resolution of ST elevation in the lead showing the greatest degree of ST elevation at presentation, hemodynamic and/or electrical instability	A9
8	**Re-occlusion post-fibrinolysis** as indicated by recurrence of chest pain, new ST elevation, hemodynamic and/or electrical instability	A9
9	**Stable patients** who have been given fibrinolytics and an elective PCI can be performed within 3 to 24 hours post fibrinolysis as part of a **pharmacoinvasive** strategy	A7

** Fit for transfer = The patient should be stabilized rapidly and ventilated if necessary prior to transfer*

C) Patients presenting between > 12 - < 24 hours of symptom onset

1	PPCI in patients presenting **> 12 hours** of symptom onset with evidence of ongoing ischemia, heart failure or hemodynamic and/or electrical instability	**A9**
2	PPCI in patients presenting **> 12 hours** of symptom onset and the patient is asymptomatic with no hemodynamic and/or electrical instability	**M5**

D) Revascularization > 24 hours after symptom onset post fibrinolysis or in those who did not receive fibrinolysis

Revascularization > 24 hours after symptom onset		**Appropriate Use Criteria (1-9)**
1	**Failed reperfusion* or re-occlusion#** after fibrinolytic therapy	**A9**
2	**Cardiogenic shock or acute pulmonary edema** that develops after initial presentation**	**A7**
3	**Spontaneous or easily provoked myocardial ischemia** such as recurrence of chest pains and/or dynamic ECG changes	**A8**
4	**Intermediate or high-risk findings** on pre-discharge non-invasive ischemia testing (Appendix IV, pg 87)	**A7**
5	**Routine coronary angiography and revascularization** in stable patients with **no demonstrable ischemia** by symptoms and on pre-discharge non-invasive ischemia testing (Appendix IV, pg 87)	**R2.5**

* *Failed re-perfusion : persistent hyper-acute ECG changes (< 50% resolution of ST elevation in the lead showing the greatest degree of ST elevation at presentation)*

\# *Re-occlusion: new ST elevation or CK-MB measurement suggest re-infarction*

** *At a non-PCI capable centre: resuscitate, stabilize, and then refer to a PCI capable centre and at a PCI capable: resuscitate, stabilize and then revascularize*

E) Other PCI strategies

	Other PCI Strategies	Appropriate Use Criteria (1-9)
1	**Rescue PCI*** initiated very early (within 1 to 2 hours) after failed fibrinolytic therapy at **a PCI capable centre**	**A9**
2	**Rescue PCI*** initiated very early (within 1 to 2 hours) after failed fibrinolytic therapy in an **unstable patient at non-PCI capable centre**	**A9**
3	**Rescue PCI*** initiated very early (within 1 to 2 hours) after failed fibrinolytic therapy in **a stable patient at non-PCI capable centre**	**A7**
4	Delayed angiography# and revascularization in patients who have **spontaneous or inducible ischemia on non-invasive testing**	**A7**
5	Routine delayed angiography and revascularization in stable patients who **do not demonstrate ischemia** on on-invasive testing	**R3**
6	**Routine PCI of totally occluded coronary arteries** 3-28 days after STEMI	**R3**

* *Rescue PCI: initiated after failed fibrinolytic therapy as indicated by ongoing chest pain, persistent hyper-acute ECG changes (< 50% resolution of ST elevation in the lead showing the greatest degree of ST elevation at presentation) or hemodynamic orland electrical instability*

\# *Delayed angiography: who did not undergo early (< 24 hours) angiography*

2.1.2 UA/NSTEMI

2.1.2 a) Definition :

Unstable angina (UA) may be classified as [29]:

I. New onset of severe angina or accelerated angina; no rest pain
II. Angina at rest within past month but not within preceding 48 hours (angina at rest, subacute)
III. Angina at rest within 48 hours (angina at rest, acute)

NSTEMI : The diagnosis is established if the symptoms listed above are present and a significantly elevated cardiac biomarker is detected.
The 3 principal presentations of **UA** are:[11]

- **Rest angina–** Angina occurring at rest and usually prolonged > 20 min, occurring within one week of presentation
- **New Onset Angina–** Angina of at least Canadian Cardiovascular Society (CCS) Class III severity and with onset within 2 months of initial presentation
- **Increasing Angina–** Previously diagnosed angina that is distinctly more frequent, longer in duration, or lower in threshold (increased by > 1 CCS class within 2 months of initial presentation to at least CCS III severity

  (Appendix V, pg 88) for CCS classification)

2.1.2 b) Revascularization in UA/NSTEMI

These are a heterogenous group of patients with variable prognosis. Risk stratification is important for selection of intervention and for revascularization strategies. The goal of revascularization is for symptom relief and to improve short and long term prognosis.

These patients should be risk stratified as follows:

Moderate - High risk features are:

- Hemodynamic instability – low BP, heart failure, worsening mitral regurgitation, arrhythmias (e.g. VT, VF)
- Dynamic ST-segment changes (≥ 1 mm or 0.1 mV depression or transient elevation)
- Elevated cardiac biomarkers (troponin more sensitive, Creatinine Kinase (CK) is also useful)
- Diabetes
- Recurrent ischemia despite optimal medical therapy
- Depressed LV function (LVEF < 40%)
- TIMI risk score ≥ 3 points (Appendix VI, pg 89)
- GRACE score > 140 (Appendix VII, pg 90-91)
- Renal insufficiency (eGFR < 60 ml/min/1.73 m^2)
- Early post infarction angina
- Recent PCI
- Prior CABG

Any one of the above features is sufficient to include the patient as High Risk.

Low risk features include:

- no angina in the past
- no ongoing angina
- no prior use of anti-anginal therapy
- normal ECG
- normal cardiac biomarkers
- normal LV function

Low Risk individuals should have all of the above features.

The following are clinical conditions or scenarios in patients with UA/NSTEMI where coronary angiography and revascularization can be considered.

A) Revascularization in Patients with UA/NSTEMI

	Clinical Condition	Appropriate Use Criteria (1-9)
1	Refractory angina and/or hemodynamic instability due to ischemia • Revascularization of culprit artery or multiple arteries if culprit cannot be clearly determined	A9
2	Recurrent myocardial ischemia in hospital • Revascularization of culprit artery or multiple arteries if culprit cannot be clearly determined	A9
3	Patient with moderate to High risk features: • Revascularization of culprit artery or multiple arteries if culprit cannot be clearly determined	A9
4	Abnormal stress testing with moderate to high risk features after initial medical stabilization (Appendix IV, pg 87) • Revascularization of culprit artery or multiple arteries if culprit cannot be clearly determined	A8.5
5	Still symptomatic after medical stabilization*	
	• Revascularization of culprit artery if stenosis > 70%	A8.5
	• Revascularization of stenosis 50-70%, if FFR < 0.8	A8
	• Revascularization of stenosis 50-70%, if FFR > 0.8	M4.5
	• Revascularization of stenosis 50-70% if FFR is not available	M6
	• Revascularization of culprit artery if stenosis < 50%	R1
6	Asymptomatic after medical stabilization*	
	• Revascularization of culprit artery if stenosis > 70%	A7
	• Revascularization of stenosis 50-70%, if FFR < 0.8	M6
	• Revascularization of stenosis 50-70%, if FFR > 0.8	R3
	• Revascularization of culprit artery if stenosis < 50%	R1

* *Non-invasive testing for ischemia not done prior to coronary angiography*

2.2 Stable CAD

Patients with stable CAD have had angina (or angina equivalent) for more than 2 months.[11] Objectives of management are to relieve angina, improve quality of life and both short and long term prognosis. Prior to revascularization, these patients should be on OMT which has been shown to reduce symptoms, myocardial ischemia and improve prognosis.[21,22] OMT includes anti platelet agents, high potency statins, ACE-I, ß-blockers and at least 2 different classes of anti-angina medications at maximal tolerated doses for at least 2 weeks together with intensive lifestyle changes.

Revascularization has been shown to be more effective than OMT in relieving angina and myocardial ischemia. Almost all large clinical studies and meta-analyses however, have not showed that an initial strategy of PCI to be superior to medical therapy in reducing death, MI or repeat revascularization during short term and long term follow up.[30-33] CABG has been shown to improve survival when compared to OMT in patients with LM or three-vessel stable CAD, particularly when the proximal Left Anterior Descending (LAD) coronary artery is involved.[34] Benefits are greater in those with severe symptoms, early positive exercise tests, and impaired LV function.[34]

This AUC aims to determine the appropriateness of revascularization in combination with OMT versus continuing OMT alone in patients with stable CAD.

2.2 a) Indications for Invasive coronary Angiography and Revascularization in Stable CAD

Invasive Coronary Angiography may be considered in the following clinical scenarios:

Indications for Invasive Coronary Angiography in Stable CAD by symptoms and Non Invasive testing**			Appropriate Use Criteria (1-9)
Angina Symptoms on *OMT	Absent	Ischemia absent or present at high work-loads on non-invasive testing	**R2**
		Ischemia present at low or intermediate work-loads on non-invasive testing	**M4**
	Minimal CCSI-II	Ischemia absent or present at high work-loads on non-invasive testing	**M4**
		Ischemia present at low or intermediate work-loads on non-invasive testing	**M6**
	Moderate to severe CCS III-IV	Ischemia absent on non-invasive testing	**A7**
		Ischemia present on non-invasive testing	**A8**

* *OMT includes lifestyle changes, antiplatelet agents, ß-blockers, statins and at least 2 different classes of anti-angina medications at maximal tolerated doses for at least 2 weeks*

** *Appendix IV, pg 87*

Revascularization in Stable CAD by extent of CAD in patients already on OMT# and still having symptoms and / or ischemia (anatomical and functional)*	Appropriate Use Criteria (1-9)
Left main stenosis > 50%**	**A9**
Any significant proximal LAD stenosis > 70%**	**A9**
2 or 3 vessel CAD with significant stenosis > 70%** and LVEF < 40%***	**A8**
2 or 3 vessel CAD with significant stenosis > 70%** and LVEF > 40%***	**A8**
1 vessel CAD with stenosis > 70%** and LVEF < 40%***	**A8**
1 vessel CAD with stenosis > 70%** and LVEF > 40%***	**A7**
1 vessel CAD with stenosis < 50%, normal LVEF, and no ischemia detected by non-invasive tests and/or FFR > 0.8	**R1**
Large area of ischemia (>10% of LV)	**A7**
Single remaining patent coronary artery with > 50% stenosis**	**A8**
Refractory symptoms (angina or angina equivalent) despite OMT in the presence of coronary stenosis of > 70%**	**A8**
PCI of a "borderline" **** lesion in a stable patient at the same sitting after an uncomplicated PCI of a "significant" lesion when non-invasive testing for ischemia or FFR of the " borderline" lesion has not been performed	**M5**

* *Adapted from 2014 ESC/EACTS Guidelines on Myocardial Revascularization. Eur Heart J 2014; 35 :2541 -2619*

** *With documented ischemia by non-invasive testing and/or diameter stenosis > 70% and /or FFR 0.80 for diameter stenosis 50%-70%*

*** *Impaired LV function: LVEF < 40%*

**** *Borderline stenosis is 50-70% luminal diameter narrowing of the epicardial coronary artery by QCA*

\# *OMT includes lifestyle changes, antiplatelet agents, ß-blockers, statins and at least 2 different classes of anti-angina medications at maximal tolerated doses for at least 2 weeks*

2.3 Mode of Revascularization

The purpose of coronary revascularization is to improve health outcomes for the patient undergoing the procedure. There is an inherent difference between the 2 modes of myocardial revascularization – PCI treats only the targeted local coronary lesion and leaves adjacent areas of at-risk vulnerable myocardium alone, whereas CABG, by bypassing the entire at-risk area of myocardium, treats both the local coronary lesion and adjacent segments.

The appropriateness of either PCI or CABG may vary depending on the clinical condition and the coronary anatomy.[15-20] They are not mutually exclusive. In a patient with complex 3-vessel CAD presenting with STEMI, PCI of the infarct related artery (IRA) may be appropriate at presentation and subsequently CABG may be the more appropriate choice. Similarly in a patient who has had previous CABG, PCI may be more appropriate for progressive native vessel or graft disease.

In these clinical scenarios the general assumptions are listed under 2a).

Mode of Revascularization in Stable CAD and UA/NSTEMI after initial medical stabilization

Coronary angiographic findings[a]				Appropriate Use Criteria (1-9)	
				PCI	CABG
1	Left main stenosis and additional CAD with intermediate to high CAD burden (Syntax score > 22)		Diabetes present	M4	A9
			Diabetes absent	M5	A9
2	Left main stenosis and additional CAD with low CAD burden (Syntax score < 22)		Diabetes present	M5	A9
			Diabetes absent	M6	A9
3	Isolated Left main stenosis (ostial and /or body)		Diabetes present	M6	A9
			Diabetes absent	A7	A9
4	Triple vessel disease with intermediate to high CAD burden (Syntax score > 22)		Diabetes present	M4	A9
			Diabetes absent	M6	A9
5	Triple vessel disease with low CAD burden (Syntax score < 22)		Diabetes present	A7	A8
			Diabetes absent	A7	A8
6	Two vessel disease	Proximal LAD involved	Diabetes present	A7	A8
			Diabetes absent	A8	A7
		Proximal LAD not involved	Diabetes present	A8	M6
			Diabetes absent	A8	M5
7	Single vessel disease with symptoms and ischemia despite OMT		Proximal LAD involved	A8	M6
			Proximal LAD not involved	A8	M4

a. CAD burden is determined by Syntax score[25] should be: (see Appendix VIII, pg 92)

2.4 AUC for Ad HOC PCI

This refers to PCI performed at the same sitting as the diagnostic coronary angiogram. The other scenarios in which PCI may be done are delayed PCI (angiogram and PCI done on different days) and same day PCI (angiogram and PCI done on the same day but at different sittings) Ad Hoc PCI is safe and effective in selected patients, cost effective, reduces hospital stay and is associated with lower rate of access site complications.[35,36] The appropriateness of Ad Hoc PCI in patients with mild stable CAD (who may be more appropriately treated with OMT alone) and those with extensive multi vessel disease and high risk patients is being questioned.

2.4 a) General Assumptions :

In addition to those mentioned in section 2a, patients undergoing coronary angiography and Ad Hoc PCI have given informed consent prior to sedation and have been advised on:

- the possible outcomes and the potential therapeutic consequences prior to the coronary angiography
- treatment options
- the risk : benefit ratio of the procedure especially in an unstable and high risk patients
- the short and long term risks and outcomes after each procedure and the importance of taking their dual anti platelet agents post PCI with stenting
- the inherent difference between the 2 modes of revascularization - PCI and CABG

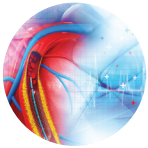
In addition:

- The patient is well hydrated and pre–treated as necessary
- Stable CAD patients have had non-invasive tests for ischemia already performed and/or facilities for FFR and/or intravascular ultrasound available on site
- There is no operator or patient fatigue
- The contrast used during the diagnostic study is within the acceptable range

Clinical scenarios in which Ad Hoc PCI may be considered

Clinical Scenario	Appropriate Use Criteria (1-9)
STEMI	
Primary PCI of the IRA	**A9**
PCI of the non-culprit vessel at the same sitting in a stable patient	**M5**
PCI of the non-culprit vessel at the same sitting in an unstable patient	**M6**
UA/NSTEMI	
Patients with refractory angina, recurrent ischemia and/or hemodynamic instability due to ischemia - Revascularization of culprit artery or multiple arteries if culprit cannot be clearly determined	**A9**
STABLE CAD	
Patients with no symptoms and non-invasive testing for ischemia has not been performed and facilities for FFR/IVUS is not available on site	**R1**
Patient on OMT and target lesion(s) are consistent with non-invasive testing and/or FFR < 0.8	**A7**
Left main or complex triple vessel disease	**R3**

Implementation and Evaluation



The AUC is not a substitute for sound clinical judgement. Decision making should be guided and not dictated by the AUC.

Not all patients are the same even if they have very similar medical history and coronary anatomy. There are other patient factors that need to be taken into consideration in the decision making process. There may be occasions where a procedure that may have been rated as "Rarely Appropriate" may have to be performed because of the patient's condition or preference. Where clinical practice varies from what is stated in the AUC, it should serve as an opportunity for both clinician and patient to review their clinical decision and document clearly in the patient's medical records the reason the procedure was performed. The AUC requires proper supportive documentation (e.g. test results, patient's symptoms, co-morbidities etc) to justify the deviation in practice from the norm. This in turn, translates to good clinical governance.

The AUC also allows clinicians to monitor their individual practice patterns and to make comparisons with their peers. If individual practice patterns routinely conflict with AUC ratings, then further evaluation and feedback should be considered.

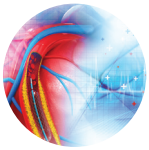
To improve supportive documentation, it is important that healthcare professionals be educated from time to time on how to calculate:

- Pre-test Probability of Disease
- Global Risk Scores (FRS)
- Syntax scores
- STS score and EuroSCORE

This AUC document should be widely disseminated via printed journals, electronic websites, regular seminars, lectures and road-shows. The public should also be made aware that this document exists. It is hoped that all clinicians in public, private and teaching hospitals incorporate this AUC document into their daily clinical practice.

In the future, appropriateness of utilization of medical technology and patient care may be assessed prospectively using the AUC as a framework.

Performance Measures

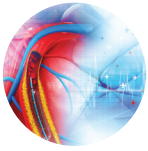


In the long term, this should lead to an improvement in patient care. In patients with stable CAD, there should be a greater emphasis on non-invasive assessment of ischemia prior to the patient undergoing coronary angiography. Suggested audit parameters are the % of patients undergoing:

- non-invasive ischemia assessment prior to coronary angiography
- revascularization who had ischemia documented

All PCI Capable centres and Cardiothoracic Surgical Centres are encouraged to participate in the NCVD-PCI registry and in the newly formed National Cardiovascular and Thoracic Surgical Database (NCTSD) Registry. The data from both these Registries can be used as audit to measure appropriateness of the intervention and type of coronary revascularization in the different centres.

Future Development



This is the first AUC on management of CAD. The recommendations may have to be reviewed as new scientific evidence from randomized controlled trials emerge and from the feedback received from healthcare professionals and the public.

Future AUCs may benefit from having a larger pool of experts to increase the diversity of the expert panels. Newer modalities such as cardiac MRI and calcium scans may also have to be incorporated into the AUCs.

Appendix

APPENDIX I:
Comparison Of Global Coronary And Cardiovascular Risk Scores

	Framingham	SCORE	PROCAM SCORE (Men)	Reynolds (Women)	Reynolds (Men)
Sample size	5,345	205,178	5,389	24,558	10,724
Age (y)	30 to 74; Mean: 49	19 to 80; Mean : 46	35 to 65; Mean: 47	> 45; Mean: 52	> 50; Mean: 63
Mean follow-up, y	12	13	10	10.2	10.8
Risk factors considered	Age, sex, total cholesterol, HDL cholesterol, smoking, systolic blood pressure, anti-hypertensive medications	Age, sex, total-HDL cholesterol ratio, smoking, systolic blood pressure	Age, LDL cholesterol, HDL cholesterol, smoking, systolic blood pressure, family history, diabetes, triglycerides	Age, HbA1C (with diabetes), smoking, systolic blood pressure, total cholesterol, HDL cholesterol, hsCRP, parental history of MI at < 60 y of age	Age, systolic blood pressure, total cholesterol, HDL cholesterol, smoking, hsCRP, parental history of MI at < 60 y of age
Endpoints	CHD (MI and CHD death)	Fatal CHD	Fatal/ nonfatal MI or sudden cardiac death (CHD and CVD combined)	MI, ischemic stroke, coronary revasculari-zation, cardio-vascular death (CHD and CVD combined)	MI, stroke, coronary revasculari-zation, cardio-vascular death (CHD and CVD combined)
URLs for risk calculators	http://cvdrisk.nhlbi.nih.gov/calculator.asp.	http://www.heartscore.org/pages/welcome.aspx	http://www.chd-taskforce.procam_interactive.html	http://www.reynoldsriskscore.org/	http://www.reynoldsriskscore.org/

APPENDIX II:
Sensitivity and Specificity of the Various Diagnostic Modalities for CAD*

	Diagnosis of CAD	
	Sensitivity (%)	**Specificity (%)**
Exercise ECG	68	77
Exercise Echocardiogram	80-85	84-86
Exercise Myocardial Perfusion	85-90	70-75
Dobutamine stress Echocardiogram	40-100	62-100
Vasodilator stress Echocardiogram	56-92	87-100
Vasodilator Myocardial Perfusion	83-94	64-90

* *Fox K, Alonso Garcia MA, Ardissino D et al for the Task Force on the Management of Stable Angina Pectoris of the European Society of Cardiology. Guidelines on the Management of Stable Angina Pectoris. Eur Heart J 2006; 27 : 1341-1381*

APPENDIX III:
Physical Activity and Metabolic Equivalents (METS)*

Metabolic Equivalent (METS) is the ratio of the work metabolic rate to the resting metabolic rate. One MET is defined as 1 kcal/kg/hour and is roughly equivalent to the energy cost of sitting quietly. A MET is also defined as oxygen uptake in ml/kg/min with one MET equal to the oxygen cost of sitting quietly, equivalent to 3.5 ml/kg/min

Physical activity	**MET**
Light intensity activities	**< 3**
sleeping	0.9
watching television	1.0
writing, desk work, typing	1.8
walking, 1.7 mph (2.7 km/h), level ground, strolling, very slow	2.3
walking, 2.5 mph (4 km/h)	2.9
cleaning, sweeping carpet or floors, general	3.3
cleaning, heavy or major (e.g. wash car, windows, clean garage, moderate effort)	3.5
sexual activity	2.8

** Adapted from : Ainsworth BE, Haskell WL, Herrmann SD, Meckes N, Bassett DR Jr et al. Compendium of Physical Activities: a second update of codes and MET values. Med Sci Sports Exerc 2011. 43: 1575–1581.*
Also available at http:// sites.google.com/site/compendiumofphysicalactivies.

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Physical activity	**MET**
Moderate intensity activities	**3 to 6**
bicycling, stationary, 50 watts, very light effort	3.0
walking 3.0 mph (4.8 km/h)	3.3
calisthenics, home exercise, light or moderate effort, general	3.5
walking 3.4 mph (5.5 km/h)	3.6
bicycling, < 10 mph (16 km/h), leisure, to work or for pleasure	4.0
bicycling, stationary, 100 watts, light effort	5.5
Vigorous intensity activities	**> 6**
jogging, general	7.0
calisthenics (e.g. push ups, sit ups, pull ups, jumping jacks), heavy, vigorous effort	8.0
running jogging, in place	8.0
rope jumping	10.0

** Adapted from : Ainsworth BE, Haskell WL, Herrmann SD, Meckes N, Bassett DR Jr et al. Compendium of Physical Activities: a second update of codes and MET values. Med Sci Sports Exerc 2011. 43: 1575–1581.*
Also available at http:// sites.google.com/site/compendiumofphysicalactivies.

APPENDIX IV:
Summary of Major Diagnostic and Prognostic Exercise Test Measures*

Measure	Description	Comments
Estimated functional capacity in METs	Based on protocol and exercise time *Predicted value in men: 14.7–0.11×Age* *Predicted value in women: 14.7 –0.13×Age* Consider abnormal if < 85% of predicted	Strongly predictive of mortality and cardiovascular events (although prognostic value of < 85% of predicted has only been validated in women)
Chronotropic response	Proportion of HR reserve use calculated as (Peak HR–Resting HR)/ (220–Age–Resting HR) *Consider abnormal if ≤ 80% (≤ 62% for patients on ß-blockers)*	Predictive of mortality and cardiovascular events; limited evidence regarding usefulness with ß-blockers
HR recovery	Difference between HR at peak exercise and HR 1 or 2 min later *With upright cool-down period, abnormal if ≤ 12 bpm 1 min into recovery* *With immediate supine position, abnormal if ≤ 18 bpm 1 min into recovery* *With sitting, recovery abnormal if ≤ 22 bpm 2 min into recovery*	Predictive of mortality, cardiovascular events, and sudden cardiac death
Ventricular ectopy during recovery	Frequent ventricular ectopics (> 7 bpm), couplets, bigeminy, trigeminy, ventricular tachycardia, or fibrillation	Uncommon but predictive of all-cause mortality
Duke treadmill score	Minutes (Bruce Protocol)– 5×ST-Segment Deviation–4×Angina Score If protocol other than Bruce used, convert to estimated Bruce minutes based on METs ST segment must be ≥ 1 mm horizontal or sloping away from the isoelectric line to be counted Angina score=1 if not test-limiting, 2 if test-limiting **Value of ≥ 5 low-risk, between – 10 and 5 intermediate risk, and ≤ 10 high risk**	Predictive of cardiovascular mortality and all-cause mortality

** Adapted from Chaitman BR. The changing role of the Exercise Electrocardiogram as a diagnostic and prognostic test for Chronic Ischemic Heart Disease. J Am Coll Cardiol 1986: 8 : 1195-1210.*

APPENDIX V:
Canadian Cardiovascular Society Classification (CCS) Of Angina

Class I	Ordinary physical activity such as walking, climbing stairs does not cause angina. Angina occurs with strenuous, rapid, or prolonged exertion at work or recreation
Class II	Slight limitation of ordinary activity. Angina occurs on walking more than 2 blocks on the level and climbing more than 1 flight of stairs at normal pace and in normal conditions
Class III	Marked limitations of ordinary physical activity. Angina occurs on walking 1-2 blocks on the level and climbing 1 flight of stairs at normal pace and in normal conditions
Class IV	Inability to carry on any physical activity without discomfort – angina symptoms may be present at rest

Campeau L. Letter. Grading of Angina Pectoris. Circulation 1976; 54 : 522-523

APPENDIX VI:
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 points

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 : 835–842 .*
- *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 VII:
Grace Prediction Score Card and Nomogram for all Cause Mortality from Discharge to 6 Months*

Risk Calculator for 6-Month Postdischarge mortality After hospitalization for Acute coronary Syndrome

Record the points for each variable at the bottom left and sum the points to calculate the total risk score. Find the total score on the x-axis of the nomogram plot. The corresponding probability on the y-axis is the estimated probability of all-cause mortality from hospital discharge to 6 months.

Medical History

1

Age in year	Points
≤ 29	0
30-39	0
40-49	18
50-59	36
60-69	55
70-79	73
80-89	91
≥ 90	100

2

History of Congestive Heart Failure 24

3

History of Myocardial Infarction 12

Findings Initial Hospital presentation

4

Resting Heart Rate Beats/min	Points
≤ 49.9	0
50-69.9	3
70-89.9	9
90-109.9	14
110-149.9	23
150-199.9	35
≥ 200	43

5

Systolic Blood Pressure, mm Hg	
≤ 79.9	24
80-99.9	22
100-119.9	18
120-139.9	14
140-159.9	10
160-199.9	4
≥ 200	0

6

ST - Segment Depression ... 12

Findings During Hospitalization

7

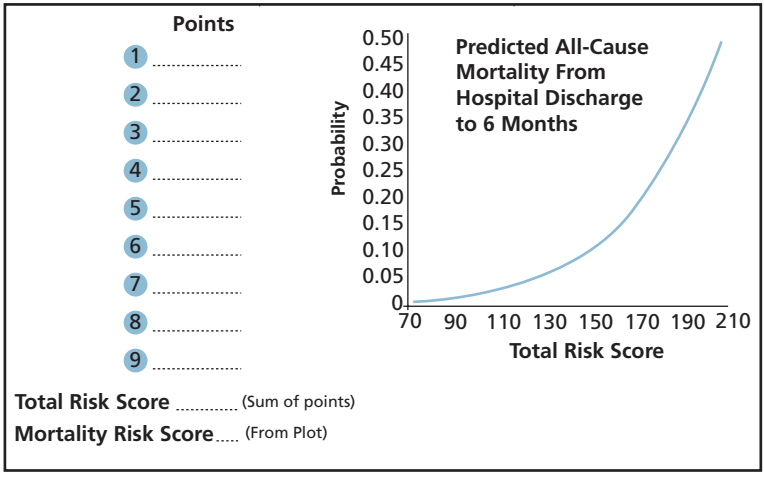
Initial serum Creatinine,mg/dL	Points
0-0.39	1
0.4-0.79	3
0.8-1.19	5
1.2-1.59	7
1.6-1.99	9
2-3.99	15
≥ 4	20

8

Elevated Cardiac Enzymes 15

9

No In-Hospital Percutaneous Coronary Intervention 14



** Eagle KA,Lim MJ,Dabbous OH et al for the Grace Investigators. A Validated Prediction Model for All Forms of Acute Coronary Syndrome.Estimating the Risk of 6-Month Postdischarge Death in an International Registry JAMA. 2004;291:2727-2733.*

APPENDIX VIII:
THE SYNTAX SCORE[25]

The Syntax score is a risk score for calculating the complexity of coronary artery lesions. It can be calculated using the risk calculator available at www.syntaxscore.com or manually by using Figure 1, pg 93 and Tables 2 & 3, pg 95 & 96 to determine:

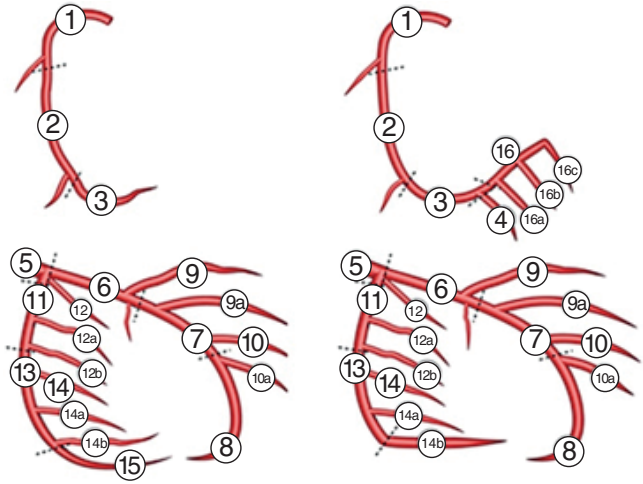
1. If right or left dominance and coronary segment (Figure 1)
2. The coronary segment weighing factors (Table 2)
3. Lesion characteristics : (Table 3)
    - the diameter stenosis
    - if trifurcation lesion
    - if bifurcation lesion
    - if aorto-ostial in location
    - if severe tortousity
    - lesion length
    - calcification
    - if thrombus present
    - if diffuse disease/small disease

The Syntax score for each lesion is calculated separately. Multiple lesions less than 3 vessel reference diameters apart (tandem lesion) are scored as one lesion. The total score is then obtained.

A Syntax score of:

- ≤ 22 would indicate low CAD burden
- > 22 to ≤ 32 would indicate intermediate CAD burden
- > 32 would indicate high CAD burden

Figure 1. Definition of the coronary tree segments



1. **RCA proximal**: From the ostium to one half the distance to the acute margin of he heart.
2. **RCA mid**: From the end of first segment to acute margin of heart.
3. **RCA distal**: From the acute margin of the heart to the origin of the posterior descending artery.
4. **Posterior descending artery**: Running in the posterior interventricular groove.
16. **Posterolateral branch from RCA**: Posterolateral branch originating from the distal coronary artery distal to the crux.
16a. **Posterolateral branch from RCA**: First posterolateral branch from segment 16.
16b. **Posterolateral branch from RCA**: Second posterolateral branch from segment 16.
16c. **Posterolateral branch from RCA**: Third posterolateral branch from segment 16.
5. **Left main**: From the ostium of the LCA through bifurcation into left anterior descending and left circumflex branches.

6. **LAD proximal**: Proximal to and including first major septal branch.
7. **LAD mid**: LAD immediately distal to origin of first septal branch and extending to the point where LAD forms an angle (RAO view). If this angle is not identifiable this segment ends at one half the distance from the first septal to the apex of the heart.
8. **LAD apical**: Terminal portion of LAD, beginning at the end of previous segment and extending to or beyond the apex.
9. **First diagonal**: The first diagonal originating from segment 6 or 7.

9a. **First diagonal a**: Additional first diagonal originating from segment 6 or 7, before segment 8.

10. **Second diagonal**: Originating from segment 8 or the transition between segment 7 and 8.

10a. **Second diagonal a**: Additional second diagonal originating from segment 8.

11. **Proximal circumflex artery**: Main stem of circumflex from its origin of left main and including origin of first obtuse marginal branch.
12. **Intermediate/anterolateral artery**: Branch from trifurcating left main other than proximal LAD or LCX. It belongs to the circumflex territory.

12a. **Obtuse marginal a**: First side branch of circumflex running in general to the area of obtuse margin of the heart.

12b. **Obtuse marginal b**: Second additional branch of circumflex running in the same direction as 12.

13. **Distal circumflex artery**: The stem of the circumflex distal to the origin of the most distal obtuse marginal branch, and running along the posterior left atrioventricular groove. Caliber may be small or artery absent.
14. **Left posterolateral**: Running to the posterolateral surface of the left ventricle. May be absent or a division of obtuse marginal branch.

14a. **Left posterolateral a**: Distal from 14 and running in the same direction.

14b. **Left posterolateral b**: Distal from 14 and 14 a and running in the same direction.

15. **Posterior descending**: Most distal part of dominant left circumflex when present. It gives origin to septal branches. When this artery is present, segment 4 is usually absent

Table 2: Coronary Segment Weighting Factors

Segment	Segment Name	Right Dominance	Left Dominance
1	RCA proximal	1	0
2	RCA mid	1	0
3	RCA distal	1	0
4	Posterior descending artery	1	N/A
16	Posterolateral branch from RCA	0.5	N/A
16a	Posterolateral branch from RCA	0.5	N/A
16b	Posterolateral branch from RCA	0.5	N/A
16c	Posterolateral branch from RCA	0.5	N/A
5	Left Main	5	6
6	LAD proximal	3.5	3.5
7	LAD mid	2.5	2.5
8	LAD apical	1	1
9	First diagonal	1	1
9a	First diagonal	1	1
10	Second diagonal	0.5	0.5
10a	Second diagonal	0.5	0.5
11	Proximal circumflex artery	1.5	2.5
12	Intermediate/anterolateral artery	1	1
12a	Obtuse marginal	1	1
12b	Obtuse marginal	1	1
13	Distal circumflex artery	0.5	1.5
14	Left posterolateral	0.5	1
14a	Left posterolateral	0.5	1
14b	Left posterolateral	0.5	1
15	Left Posterior descending	N/A	1

Table 3: Lesion Characteristics

Aorto ostial stenosis	+1
Bifurcation, Medina classification*	
Type 1-0-0, 0-1-0, 1-1-0	+1
Type 1-1-1, 0-0-1, 1-0-1, 0-1-1	+2
Angulation < 70°	+1
Trifurcation	
1 diseased segment	+3
2 diseased segments	+4
3 diseased segments	+5
4 diseased segments	+6
Diameter reduction	
Total occlusion	×5
Significant lesion, 50% to 99%	×2
Total Occlusion (TO)	
Age > 3 months or unknown	+1
Blunt stump	+1
Bridging	+1
First segment visible beyond TO	+1/ per nonvisible segment
Side branch (SB)	
Yes, SB < 1.5 mm	+1
Yes, SB both < 1.5 mm & ≥ 1.5 mm	+1
Severe tortuosity proximal to the lesion	+2
Length > 20 mm	+1
Heavy calcification	+2
Thrombus	+1
Diffuse disease/small vessels *Present when at least 75% of the length of the segment distal to the lesion has a vessel diameter of < 2mm, irrespective of the presence or absence of disease at that distal segment*	+1/ per nonvisible segment

MS Excel 2010 formulas used to assess appropriateness and disagreement.

Median of panel rating	=MEDIAN(x:x)
30th percentile	=PERCENTILE.EXC(x:x;0,3) or Firstly, the rank is calculated: n=30/100 * (N-1) + 1 where N is the number of respondents then, the rank is split such that n=k+d, where k is the integer and d the decimal component v30= vk + d[v(k+1)-vk]
70th percentile	=PERCENTILE.EXC(x:x;0,7) or n=70/100 * (N-1) + 1 where N is the number of respondents then, the rank is split such that n=k+d, where k is the integer and d the decimal component v70= vk + d[v(k+1)-vk]
Interpercentile range 30th-70th	=[70th percentile]-[30th percentile]
Central point IPR	=([70th percentile]+[30th percentile])/2
Asymmetry Index	=ABS(5-[central point IPR])
IPRAS	=2,35+(1,5*[Asymmetry index])
IPRAS-IPR	=[IPRAS]-[IPR]

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