



**Australian Society of Medical Imaging and Radiation Therapy**

The national professional organisation representing medical radiation practitioners

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# MIAP1

May 2017

MEDICAL IMAGING ADVISORY PANEL 1

## Course Syllabus

*Cardiac & Vascular Interventional Imaging (Angiography)*

**CARDIAC Stream**

# Section A: Angiographic Equipment

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## TOPICS:

### **General**

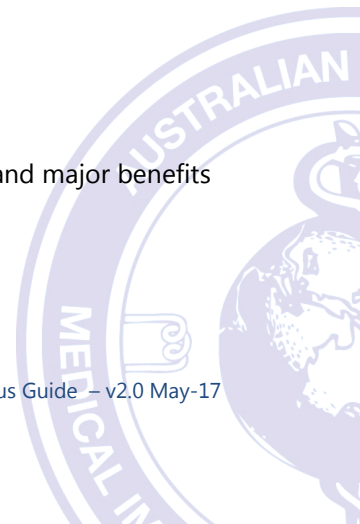
- Understand the French sizing system

### **Sheaths**

- Understand vascular sheaths
  - General design and purpose
  - Use of long Sheaths
  - Purpose of Break-Away (peel apart) sheaths

### **Catheters**

- Understand the terms
  - Pushability
  - Crossability
  - Torque
  - Steerability
- Compare and contrast the shape, characteristics and use of the following flush catheters
  - Pigtail
  - Contra/VCF/ Omni Flush
- Understand the general (visual) shape of the following catheters
  - JR4
  - AL1
  - JL4
  - IM
- Understand the common uses of the following catheters (principle anatomical engagements)
  - TIG
  - JR4
  - AL1
  - IM
- Understand the design and primary uses of Glide Catheters
- Understand the following characteristics of Guide Catheters
  - Sizing
  - Indications for use
  - How they differ from a standard diagnostic catheter
- Understand the general definition of a micro-catheter and describe its applications and major benefits



## **Guide Wires**

- J-Wires vs. straight wires
  - Indications for use
  - Advantages and disadvantages
- Understand the design and general use of Glide Wires
- Compare and contrast the following wire-based delivery systems
  - 0.035 vs 0.014
  - Understand the primary uses (and limits) of each system in coronary angiography/angioplasty
- Know the primary uses, general length, and disadvantages associated with the use of Exchange Wires
  - Standard exchange
  - Stiff exchange
    - Amplatz

## **Balloons**

- Understand the term balloon compliance
  - Compare the uses of compliant vs. non-compliant balloons
- Understand the following angiography balloon terms
  - Rated Burst Pressure
  - Nominal Pressure
  - Difference between circumferential and longitudinal balloon rupture
- Specialist balloons
  - Cutting balloons - Describe the design and indications of cutting balloon use
  - Drug Eluting Balloons – describe their uses and the drugs routinely applied

## **Stents**

- Compare and contrast Self Expanding and Balloon Expandable Stents
  - Delivery mechanisms
  - Advantages vs. disadvantages (including radial strength characteristics)
- Understand the design and general uses of Covered Stents
- Indications and differences between drug eluting and bare metal coronary stents
- Understand what is meant by 'in-stent restenosis'
  - Causes
  - Treatment



# Section B: Angiographic Anatomy, Pathophysiology & Pharmacology

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## TOPICS:

- Identify the macroscopic and microscopic structure of arteries and veins
- Understand the principles of Virchow's triad
- List pathological processes that may result in arterial narrowing
  - Intrinsic vs. extrinsic
    - Acute
    - Chronic
- List pathological process that result in vascular occlusion
  - Acute
  - Chronic
- Understand the pathological process behind aneurysm development
  - Fusiform vs. saccular vs. mycotic
  - True vs. false (pseudo) aneurysm
- Understand the following terms
  - Arterio-venous malformation
  - Arterio-venous fistula

## ***Arterial Anatomy - Principles***

- Describe the composition of the femoral triangle
- Understand the structure of an artery (Intima, Media, Adventitia)
- Understand what is meant by left vs. right coronary artery dominance
- List the arterial supply to the heart indicating which portion of the heart is supplied by each vessel
- Understand the chambers and valves of the heart
  - Functional and anatomical (structural) differences between each chamber
  - Valve locations and anatomical (structural) differences
- List the arterial pathway for a coronary arteriogram using
  - A right radial access approach
  - A right femoral access approach
- List the arteries (and veins) commonly used for Coronary Artery Bypass Grafting
  - Understand the difference between venous and arterial grafts
- List the arteries of the aortic arch (the great vessels)
  - Understand the positions (proximal/distal) relative to the arch
- List the names of the structure of the ascending aorta
  - Aortic sinuses
  - Coronary artery origins
  - Structural anatomical junctions



## **Bloodwork**

### **Clotting Factors**

- Understand the clinical relevance of a low haemoglobin level, and its primary causes
- Understand an International Normalised Ratio (INR) test and when it should be performed
- Discuss the functions of platelets during vessel haemostasis.
  - Understand the implications of a low platelet count
- Understand an Activated Clotting Time (ACT) test and when it should be performed

### **Renal Function**

- Understand the clinical importance of Glomerular Filtration Rate (GFR) tests in angiography, and know the levels for safe operation
- Understand Creatinine: What it is, how it is produced, and how to manage high levels prior to angiography
- Understand Urea: What it is, how it is excreted, and the clinical relevance of low levels

### **Troponin**

- Understand Troponin testing: Why it is done, safe levels, and what it reveals clinically

## **Drugs**

- Lignocaine
  - Drug class
  - Common dosing
  - Effect of combining with Epinephrine
- Fentanyl
  - Drug class
  - Primary Uses
  - Common dosing
- Midazolam
  - Drug class
  - Primary Uses
  - Common dosing
- GTN
  - Discuss the primary angiographic use
  - Mechanism of action
- Heparin
  - Drug class
  - Primary angiographic uses
  - Common dosing
- Indications for use during angiography:
  - Adrenaline
  - Atropine



# Section C: Angiographic Physics

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## **Radiation Biology & Safety**

- Understand what contributes to patient dose in fluoroscopic procedures
  - Types of photons (transmitted, scattered and absorbed)
  - Common methods for reducing these doses
- Understand what contributes to operator dose in fluoroscopic procedures
  - Areas of highest scatter dose
  - Types of photons (transmitted, scattered and absorbed)
  - Common methods for reducing these doses
- Discuss the importance and uses of Diagnostic Reference Levels (DRL) in angiography
  - Understand how DRL values are arrived at
- Compare and contrast acute and chronic radiation injury
  - Define each type
  - Common forms these injuries may take
  - Trigger levels

## **Radiation Dose Metrics**

- Describe the location and purpose of the Interventional Reference Point (IRP)
  - Understand the implications of changing table height on the resultant radiation dose measurements
- Understand Dose Area Product (DAP)
  - What it is
  - Where it is measured
  - Clinical relevance
- Discuss Air Kerma (AK)
  - What is it
  - Clinical relevance, and how it differs from the Surface Entrance Dose
  - Understand how to determine the maximum skin dose (single region) where multiple projections have been used

## **Radiation Protection**

- Know the Australian Standards for
  - Heavy lead gowns
  - Annual absorbed dose limits

## **Imaging Physics**

- Understand the effects of a changing field of view (FOV) on patient dose
  - Collimation vs. magnification
- List image magnification changes with changes to the following
  - Source-to-image distance



- Source-to-object distance
- Object-to-image distance
- Know the common focal spot sizes in use in angiography, and understand
  - The effect on image resolution
  - The effect on heat loading
- Understand the effects of changing matrix size on image resolution
- Understand what the Detective Quantum Efficiency (DQE) says about an angiography system.
  - What is its relevance?
- Vessel calibration methods
  - Understand the limitations of each method (foreshortening, magnification, errors induced when calibrating from small distances)
    - Measuring catheters
    - Catheter/sheath width calibration
    - Automatic (magnification factor) calibration
    - Ruler calibration (top of table, or on top of patient)

### ***Bi-Plane Angiography***

- List advantages of bi-planar angiographic systems
- List disadvantages of bi-planar angiographic systems
- Understand the uses of bi-planar imaging during cardiac imaging

### ***Digital Subtraction Techniques***

- Understand the creation of DSA images
  - Understand why DSA is not routinely used in coronary angiography
  - Understand the use of mask images

### ***Contrast Injection Principles***

- Understand Poiseuille's Law
  - Factors affecting the pressure of injection
  - Maximising injection flow rates
- Understand the use of angiographic powered injectors and what each parameter controls
  - Injection rate
  - Injection volume
  - Injection delay
  - X-ray delay
  - Rate rise
  - Pressure limit
- Understand injection related 'catheter recoil' and how this can be minimised



## Section D: Fundamental cardiac angiographic *principles*

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### **General Principles**

- Understand why patients must remain still during procedures and the methods used to achieve this
- Understand why monitoring a patient's blood pressure, oxygen saturation, and respiratory rate during a procedure is important
- Understand the risks of pressure injury and for the patient and ways to prevent this

### **Sterile Technique**

- Understand basic principles of sterile technique *as they relate to the procedure, staff, patient and xray equipment*
- Why and how sterile gowns/gloves/drapes are used
- How to dispense sterile equipment/fluids into the sterile field
- Cleaning preparation of the access site
- Use of personal protective equipment in the procedure room

### **Vascular Access**

- List all steps (in order) of the 'modified' Seldinger technique
  - Indicate equipment required at each stage
- Compare and contrast radial vs. common femoral arterial access
  - Indications
  - Contraindications
  - Post-operative benefits
- Know what the Allen's Test is and how it is performed
- List potential complications related to arterial access
- Understand vessel closure methods
  - Radial access
  - Femoral access
    - Manual Pressure
    - Fem-Stop process
    - Vascular closure devices

### **Patient Care, Procedural Risks & Complications**

- Understand the risks and complications of coronary angiography
  - Procedural
  - Post-procedural
- List major and minor complications related to the injection of iodinated contrast media
- Understand the concepts of post procedural patient care
  - Haematoma risk
  - Radial vs Femoral approach
  - Differences between diagnostic coronary angiography and PCI procedures





- Understand the key concepts of patient preparation for coronary angiography
  - Fasting
  - Warfarin
  - Access Site Preparation

### ***ECG Interpretation***

- Understand why the ECG is monitored in the Cardiac cath lab
- On an ECG rhythm strip, be able to recognise the P, Q, R, S and T waves
- Understand what each wave on the ECG represents physiologically
- Know what is meant by an arrhythmia
- On an ECG rhythm strip, be able to recognise:
  - Ventricular Fibrillation (and know what to do)
  - Ventricular Tachycardia (understand the difference to ventricular fibrillation)
- On an ECG rhythm strip, be able to recognise:
  - Ventricular Standstill (and understand its importance)
  - ST elevation
- Know the basic functions of an automatic external cardiac defibrillator
- Understand what is meant by bradycardia and tachycardia
- Understand the SA and AV nodes
  - Where they are located
  - What are their functions
- Have a basic knowledge of the electrical conduction through the heart



## Section E: Fundamental cardiac angiographic *procedures* – Part 1: Coronary/Arterial procedures

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### **Angiographic Procedures: Cardiac Angiography**

- Understand why monitoring a patient's intra-arterial blood pressure is important for cardiac procedures
  - How is this achieved
- List indications and contra-indications for performing diagnostic cardiac angiography
- List projections required to demonstrate the left main coronary artery
- List projections required to demonstrate the left anterior descending artery
- List projections required to demonstrate the circumflex artery
- List projections required to demonstrate the right coronary artery
- Describe left ventriculography
  - Indications
  - Projection
  - Catheter used
- Understand the use of the *pullback gradient* after entering the left ventricle
  - Understand the normal gradient value
  - What does a high gradient value clinically mean
- For arch aortography list
  - Indications
  - Standard projection
  - Catheter used
  - The normal diameter of the ascending aorta

### **Angiographic Procedures: Coronary Angioplasty (PCI)**

- Understand what *Percutaneous Coronary Intervention* is and when it is performed
  - Understand the Chronic Total Occlusion (CTO) variation of the PCI procedure
- Understand the different lesion classifications (Types A, B, C)
  - Understand how the lesion classification may affect PCI treatment
- Understand the different stages of the PCI procedure
- Understand the use of guide catheters during PCI
  - Reasons for use
  - Understand why some guide catheters have side holes, and when they should be used
- Understand the principle radiographic elements of proper lesion assessment
  - The importance of using orthogonal views
  - The implications of image foreshortening in lesion sizing
- Understand why Heparin and GTN are used during PCI procedures
- List the basic complications of PCI
  - Procedural
  - Post-procedural
  - Radiation dose implications for patients and staff during extended PCI procedures



- Understand Acute Coronary Syndrome (ACS)
  - Symptomology
  - Understand the difference in patient presentations for ACS vs a stable, elective PCI procedure
  - Understand why ACS procedures must be performed in a timely manner
- Understand what is meant by ST Elevation Myocardial Infarction (STEMI)
  - Understand the difference between STEMI and NSTEMI presentations
- Understand the TIMI Flow Score and its clinical procedural relevance
- Understand Fractional Flow Reserve (FFR)
  - How it works
  - What the results clinically/physiologically represent
  - Why it may be used prior to PCI
  - The function and use of adenosine during testing

### ***Angiographic Procedures: Right Heart Procedures***

- Understand the primary indications for a right heart procedure
- Understand the normal ranges for the blood pressure in each of the right heart chambers
- Be able to recognize where a Swan Ganz catheter is purely from its visual pressure trace characteristics
  - Understand the pressure trace characteristics of the following four regions
    - RA
    - RV
    - PA
    - PWP
- Describe the construction of a Swan Ganz catheter and its use
  - Why does it have a balloon at its tip
  - Functions of the thermister
- Understand cardiac output testing
  - What is meant by Cardiac Output (what are the variables)
  - How is it measured during a right heart procedure
  - What is the relationship between the rate of blood flow and the change in temperature
- Understand the use of thermo-dilution during cardiac output studies
  - Why are multiple readings taken
- Understand what is meant by *pulmonary wedge pressure*
  - How can it be used to assess mitral valve gradients
  - How can it be used in the assessment of acute pulmonary oedema
- Understand how structural heart defects may be diagnosed during a right heart procedure
  - Left-to-right heart shunts
  - Paediatric/congenital deformities
- Understand how pulmonary valve gradients may be measured and their clinical relevance



## Section E: Fundamental cardiac angiographic *procedures* – PART 2: Electrical and structural procedures

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### **Angiographic Procedures: Pacemaker Procedures**

- List the main indications for:
  - A permanent pacemaker (PPM)
  - An Automatic Internal Cardiac Defibrillator (AICD)
- Understand the functions of a pacemaker
  - Understand the differences between a PPM and an AICD
  - Understand the difference between single lead and dual lead pacing systems
  - Understand the difference between temporary and permanent pacing systems
- Understand pacemaker lead design and function
  - Understand the differences between *sensing, pacing and shocking*
  - Understand the differences between a *passive pacing* lead and an *active fixation* lead
- Understand loop recorder devices (Linq)
  - Where are they implanted
  - Why are they implanted
  - How do they differ from a PPM
- Understand bi-ventricular devices
  - How they differ from a standard pacing system
  - Describe the route taken by the left ventricular lead
  - Understand how a bi-ventricular device may assist cardiac function
- List the standard/common locations for a pacemaker generator
- List the main complications of inserting permanent pacemakers
  - Which plain x-ray is of most value post procedure
  - Understand the importance of sterility during permanent pacing procedures
- Understand the differences in radiographic quality requirements between pacemaker, bi-ventricular pacing and coronary angiography procedures
  - Magnification
  - Exposure parameters
- Understand the radiation exposure differences between
  - A loop recorder insertion
  - An easy single lead PPM insertion
  - A complicated three lead bi-ventricular AICD insertion
  -

### **Angiographic Procedures: Electrophysiology (EP) Procedures**

- List the main indications for an EP study
- Understand the following EP studies:
  - A diagnostic EP procedure
  - A Pulmonary Vein Isolation (PVI) procedure
- Understand *Cryo-ablation* and *Radio-Frequency Ablation* (RFA) therapies
  - The differences between the two
  - Understand how these methods are used to treat abnormal electrical pathways in the heart



- List the standard access routes for EP catheters
- Understand trans-septal punctures
  - When and why is it used during some EP procedures
  - Understand its risks
  - Describe the technique
- Understand the design and function of EP catheters
  - Describe where the CS catheter would sit during an EP study
- Understand the uses of the following drugs during an EP study
  - Flecainide
  - Isuprel (Isoprenaline)
- Understand the purpose of using an additional 3D mapping system (Carto, Navix, Prucker) during EP cases
  - Indications for use
  - Procedural benefits
  - Implications for radiation dose
- Understand the differences in radiographic quality requirements between EP studies and coronary angiography procedures

### ***Angiographic Procedures: Structural Heart Procedures***

- Understand Atrial Septal Defects (ASD)
  - Indications for closure
  - List what size ASD would be referred for surgery
  - What type of device is used to close an ASD
  - Know how an ASD can be measured angiographically
- Understand Patent Foramen Ovale (PFO) procedures
  - Understand the anatomical relationships
  - Indications for closure
  - Difference between an ASD and a PFO
- Understand Patent Ductus Arteriosus (PDA) closure procedures
  - Understand the anatomy and pathophysiology of a PDA
  - Understand the circumstances under which a PDA would be closed
  - Understand the access routes for a PDA closure
- Understand Aortic Valvuloplasty procedures
  - Indications
  - Understand why rapid ventricular pacing is required for aortic valvuloplasty
  - List the major complications of aortic valvuloplasty
- Understand Trans-Aortic Valve Implantation (TAVI) procedures
  - Indications
  - Understand why accurate profiling of the aortic sinuses is important in TAVI procedures
  - Why is accurate sizing of a TAVI device so important
  - What peripheral vascular presentations will prevent the use of a TAVI procedure
- Understand why a left atrial appendage (LAA) would require closure
  - Know the different ways in which a left atrial appendage orifice can be measured
- List the 3 main shapes of the left atrial appendage
  - List is the best fluoroscopic projections to profile the LAA orifice



## Section F: Angiographic/Fluoroscopic Image Labelling

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### **List and/or Label the Following Anatomical Structures:**

#### **Thoraco-Abdominal**

- Aortic arch and great vessels
- Abdominal aorta
  - Coeliac artery
  - Superior mesenteric artery
  - Renal arteries
  - Lumbar arteries
- Pelvic Arteries
  - Common iliac
  - Internal iliac
  - External Iliac

#### **Coronary Arterial Anatomy**

- Left main coronary artery
- Left anterior descending artery
  - Diagonals
  - Septals
  - Anterior interventricular (mid and distal left anterior descending artery)
- Left Circumflex artery
  - Atrial branch
  - Obtuse marginal
- Ramus Intermediate
- Right Coronary Artery
  - Conus branch
  - Right ventricular branch
  - Right acute marginal branch
  - Posterior descending artery (in right coronary dominant system)
  - Postero-lateral left ventricular branch (in right coronary dominant system)

#### **Peripheral**

- Upper arm arterial supply
  - Subclavian artery and branches
  - Axillary artery
  - Brachial artery
  - Radial, ulnar and interosseous arteries
- Label the anatomy of the lower limb arteries
  - Common femoral arterial bifurcation
  - Superficial and Deep (profunda) femoral

