Diploma of Medical Ultrasonography (DMU) (Vascular)

Syllabus
INTRODUCTION

This syllabus is divided into two parts. Part 1 forms the foundation for Part 2. Part 2 continues with the acquisition of knowledge and concentrates on the acquisition of skills.

i. Philosophy/Perspective

Diagnostic ultrasound is firmly established in medical practice. Ultrasound facilitates decisions regarding patient management and the sonographer plays a significant role in the diagnostic team. The training and assessment processes need to reflect the responsibilities required of the sonographer.

ii. Theory And Training

As health care professionals, the sonographer’s role is to perform imaging to a high standard and to provide accurate information to aid in the correct management of the patient. Vital to the performance of a high standard of practice are several factors including:

- The assimilation of factual knowledge and understanding of relevant physical principles of ultrasound, instrumentation, anatomy, physiology, pathology and, where applicable, therapeutic intervention
- Acquisition and understanding of the required technical skills
- Acquisition and appropriate use of high-level oral and written communication skills
- Acquisition of interpersonal skills necessary for the sonographer to function in a professional, competent, caring and compassionate manner

Clinical supervision is provided by the practice in which the sonographer is working. It is recognised that some trainees may not be exposed to the broad range of ultrasound applications in one institution. Where there are local limitations, experience should be sought elsewhere. Participation in day-to-day reporting, clinical conferences and scientific meetings is strongly advised. Emphasis is placed on current knowledge and skills. A commitment to continuing education is a professional responsibility.

iii. Responsibilities

In the delivery of a high quality professional service the responsibilities of the sonographer include:

- Clear communication with the patient and other medical staff
- Preparation of the patient for the examination
- An ability to obtain informed consent
- Confidentiality with patient information
- Care and comfort of the patient during the examination
- Familiarity with emergency procedures
- Strict adherence to infection control practice
- Safe work practices in accordance with current standards of occupational health and safety considerations
- Care and maintenance of equipment
- Acquisition of appropriate information to be presented to the medical practitioner for consideration and reporting
- Awareness of professional, legal and ethical aspects of sonographic practice
- Sensitivity to cultural differences
- Quality control of equipment and practical and administrative details
- A commitment to continuing education

ASUM policies, statements and clinical protocols are applicable where appropriate in the above points.
PART 1 DMU (VASCULAR) SYLLABUS

A successful DMU candidate will be able to display in the DMU assessments an understanding of human anatomy, physiology, embryology, and pathology as related to the investigation of a vascular patient with ultrasonic and related non-invasive techniques. They will be able to use and understand terminology conveying information about anatomical structures, anatomical positions, relative directional terms and body planes.

The anatomy of arteries, veins and the lymphatic system should be understood in sufficient detail to allow correct identification by name, of blood vessels, the vascular beds that the vessels feed and the collateral pathways that develop subsequent to disease. The structure of different vessels, their location and role in the circulation, and the composition of their walls would be information that the candidate would be expected to know.

As the heart is the driving force of the vascular system, its location, structure, function and the interrelationship between venous return and cardiac output should all be understood.

This syllabus has been compiled to provide you with a detailed knowledge of the topics that may be examined in the Part 1 written assessment. When preparing for the Part 1 written assessments you will be expected to know the information in the:

- core textbooks on the Reading List
- recommended textbooks on the Reading List. These provide the same content but the information is presented differently.
- learning guides that are specifically related to the core texts listed

a. i. Anatomy
   - Anatomical terminology
   - Anatomical positions
   - Relative directional terms of the body
   - Body planes

ii. Blood Vessels
   - Structure and functional anatomy of:
     - arteries
     - veins
     - capillaries
     - arterioles
     - venules

iii. The Heart
   - Location
   - Covering
   - Structure
   - Chambers
   - Valves
   - Blood supply to the heart
   - Great vessels arising from the heart
   - Blood flow through the heart
   - Venous drainage of the heart
- Great veins entering the heart

The major arteries and veins are listed to aid your study preparation. You may also be examined on:
  - the regions that these vessels supply
  - their relationship to other structures/organs

You will also be required to know about:
  - anatomical variations
  - possible collateral pathways

iv. Arteries of the head and neck
- Internal carotid artery and branches
- External carotid artery and branches
- Circle of Willis
- Periorbital circulation
- Vertebral arteries and branches

v. Veins of the head and neck
- Internal jugular and tributaries
- External jugular and tributaries
- Vertebral venous plexus

vi. Arteries of the thorax
- Aortic arch and branches
- Thoracic aorta
- Innominate and subclavian arteries and branches

vii. Veins of the thorax
- Superior vena caval system
- Azygos vein:
  - hemiazygos
  - accessory azygos
- Brachiocephalic veins and tributaries
- Subclavian veins and tributaries

viii. Arteries of the upper extremities
- Axillary arteries and branches
- Brachial arteries and branches
- Profunda brachial arteries
- Radial arteries and branches
- Ulnar arteries and branches
- Deep and superficial palmar arches
- Digital arteries

ix. Veins of the upper extremities
- Axillary veins and tributaries
- Brachial veins
- Radial veins
- Ulnar veins
- Cephalic veins
- Basilic veins
- Median cubital veins
- Dorsal venous arches
x. Arteries of the abdomen and pelvis
- Abdominal aorta
- Coeliac trunk, branches, and common variants
- Superior mesenteric artery and branches
- Renal arteries and common variants
- Inferior mesenteric artery and branches
- Testicular / ovarian arteries
- Lumbar arteries
- Median sacral artery
- Iliac arteries/ branches

xi. Veins of the abdomen and pelvis
- Inferior vena caval system
- Portal venous system
- Hepatic veins
- Renal veins and tributaries
- Testicular / ovarian veins
- Iliac veins and tributaries

xii. Arteries of the lower extremities
- Femoral arteries and branches
- Superficial femoral arteries
- Popliteal arteries and branches
- Infrapopliteal arteries and branches
- Dorsal metatarsal arteries and branches

xiii. Veins of the lower extremities
- Common femoral veins and tributaries
- Popliteal veins and tributaries
- Great and small saphenous systems and tributaries
- Digital veins
- Venous valves
- Soleal sinuses
- Perforating veins

b. Embryology
As some of the pathologies or anatomical variants detected by the vascular sonographer result from congenital defects, the candidate needs to have an understanding of the embryological development of the heart and blood vessels.

i. Blood vessel formation
- A general understanding of the development of the fetal and umbilical vessels

ii. Development of the heart
- Cardiogenic area
- Angioblastic cords
- Endothelial heart tubes
- Bulbus cordis
- Truncus arteriosus
- Sinus venosus
- Aortic sac
• Aortic arches
• Partitioning of the heart
• Primitive circulation
• Fetal circulation and changes at birth

iii. Development of the arterial system
• Derivatives of the aortic arches
• Umbilical arteries

Congenital anomalies of the heart, great vessels and aortic arches
• Atrial septal defects
• Ventricular septal defects
• Persistent truncus arteriosus
• Transposition of the great arteries
• Coarctation of the aorta
• Patent ductus arteriosus
• Abnormal origin of the right subclavian artery
• Double aortic arch
• Interrupted aortic arch
• Right aortic arch
• Abnormal origin of the left common carotid artery

Development of the venous system
• Umbilical veins
• Cardinal veins:
  o inferior vena cava
  o azygos vein
  o superior vena cava
• Pulmonary veins

Abnormalities of the venous development
• Double inferior vena cava
• Absence of the inferior vena cava
• Left superior vena cava
• Double superior vena cava
• Persistent left superior vena cava

c. Physiology of the cardiovascular system
The use of duplex ultrasound allows not only visualisation of blood vessels but also the interrogation of blood flow characteristics using pulsed wave (PW) Doppler. Therefore, the DMU Vascular candidate is expected to have a good knowledge of the haemodynamics of normal flow in the various vessels of the circulation. The changes that occur with anatomical variations and pathological process must be fully appreciated by the vascular sonographer in order to interpret their duplex findings.

i. Blood distribution
• Pulmonary circulation
• Systemic circulation
• Subdivisions of the systemic circulation
  o portal
  o cerebral
  o cutaneous
  o skeletal muscle
ii. **The Heart**
   - Mechanical and electrical events of the cardiac cycle
   - Neural and humoral regulation of:
     - heart rate
     - stroke volume
     - cardiac output
   - Intrinsic regulation of cardiac output

iii. **Haemodynamics**
An in-depth knowledge of the physiological regulation of blood flow volume, pressure and impedance is required to understand and interpret normal and pathological ultrasound observations.

iv. **Principles of blood flow**
   - The forms of fluid energy and the conservation of energy and mass in arterial flow
   - The relationship between blood flow volume, pressure and velocity
   - The properties of vessels which influence pressure and flow volume
   - The properties of vessels which influence impedance
   - The changes in fluid energy through a stenosis with and without energy loss
   - Rheologic properties which influence blood flow

v. **Factors affecting blood pressure**
   - Formation and characteristics of flow velocity profiles, including plug and parabolic pulsatile flow and its conversion to continuous flow
   - The influence of inertia and elasticity in arterial flow
   - The physical and physiologic factors affecting blood pressure
   - Characteristics of laminar and turbulent flow
   - The physical properties of arteries which affect waveform shape
   - Changes in the arterial waveform shape and the influence of reflected waves
   - Principles of blood pressure measurement by sphygmomanometer

vi. **Microcirculation and Lymphatics**
   - Characteristics of arterioles and capillaries and the role of endothelium in controlling blood flow
   - The process of capillary filtration and its control by oncotic and hydrostatic forces
   - The role of the lymphatics in maintaining tissue fluid balance

vii. **Regulation of blood pressure**
   - The role of endothelium and tissue metabolism in the intrinsic control of blood flow
   - The extrinsic control of blood flow and the influence of neural and humoral factors
   - The mechanism of neural and chemical feedback mechanisms in blood pressure control
   - Understand the cardiovascular consequences of haemorrhage and the compensatory mechanisms involved in compensating for blood loss

**Venous haemodynamics**
   - The interaction of gravity and venous pressure during changing posture and movement
   - The role of muscular activity and respiratory activity on venous return to the heart

d. **PATHOLOGY**
   i. **General Principles**
      - General characteristics, classification and incidence of disease
Haemostasis
- Process of coagulation and thrombosis formation

ii. Cell injury and repair
- Responses to cellular injury and the modes of cell repair and regeneration

vi. Inflammation
- Causes, stages and effects of acute and chronic inflammation

v. Disease of blood vessels
- Risk factors and sequence of events in the development of atheroma
- Processes of ischaemia, infarction and shock

vi Neoplasia and carcinogenesis
- Characteristics and behaviour of neoplasia and carcinogenesis

vii. Genetic basis of disease
- The role of genetic and environmental causes of disease

viii. Immunology
- Understand the principal features of the immune system and how they contribute to pathologic states.

NOTE: It is each candidate’s responsibility to ensure that they have covered all the areas in this syllabus using all the resources available to them.

PART 2 DMU (VASCULAR) SYLLABUS

a. General Considerations
The sonographer will be expected to attain competence in the performance and interpretation of diagnostic ultrasound examinations. Along with a review of relevant Part I material, emphasis will be placed on application of this knowledge and its integration with the development of technical skills, image interpretation and patient care. This will involve reviewing and understanding all aspects of the Part 1 syllabus and the technical requirements necessary to produce ultrasound images that display normal and abnormal findings. For any examination, the sonographer will be expected to:
- Understand the clinical indication for the examination
- Assess the suitability of ultrasound to answer a particular question and recognise any limitations presented by:
  o patient condition/habitus
  o equipment available
  o personal skills
- Explain the procedure to the patient
- Be aware of the needs of the patient during the examination
- Maintain a good level of communication with the patient throughout the procedure to ensure that patient needs are met
- Obtain clinically relevant and diagnostic images and measurements

You are strongly advised to review the DMU (Vascular) Part I syllabus as it is the foundation for the Part 2 syllabus. In Part 2, you will be expected to know Part 1 and Part 2 Syllabus.

a. Fundamental Knowledge
• Anatomy
• Physiology
• Pathology
• Embryology
• Physical principles and instrumentation in Doppler and B-Mode ultrasonography
• Legal and ethical issues

b Spectral Analysis in Doppler Ultrasound
Is widely used in the assessment of the vascular patient. PW Doppler provides information about haemodynamics and perturbations to flow. The vascular sonographer requires understanding of the clinical significance of PW Doppler spectral analysis as described by the following:
• Understand the clinical applications of spectral analysis
• Flow features associated with spectral display
• Normal flow disturbances
• Effects of sample volume
• Local effects of arterial stenosis
• Proximal and distal effects of arterial obstruction
• Poststenotic flow disturbances
• Secondary (Collateral) manifestations of atrial stenosis
• Measurements:
  o velocity ratios
  o acceleration rates
  o volume flow
• Effects of other pathologies on the spectral display

c. Colour and Power Duplex Sonography
Colour and Power Doppler adds another dimension to the duplex investigation of the vascular patient. The DMU (Vascular) candidate requires sound knowledge and skill in the application of the following:
• Principles of Colour and Power Doppler
• Advantages of Colour and Power Doppler
• Limitations of Colour and Power Doppler
• Correct adjustment of colour controls
• Artefacts in Colour and Power Doppler imaging

d. Classic Signs and Symptoms of Vascular Disease
The vascular sonographer needs to be able to communicate effectively with their patient to gain information about the client’s clinical symptoms and to determine clinical signs of different forms of vascular disease including:
• Arterial diseases, atherosclerotic, aneurysmal, non-atherosclerotic
• Venous diseases, both obstructive and due to valvular incompetence
• Lymphatic pathologies

It is expected that a vascular sonographer is able to communicate effectively with the patient to help elicit disease risk factors, clinical symptoms and determine clinical signs of various forms of vascular disease, such as;
• arterial diseases
  o venous diseases
  o lymphatic diseases
e. Haemostasis And Thrombosis
There are numerous related factors that play active roles in the process of thrombus formation and thrombolysis. These factors and the process need to be understood in relation to the clinical presentation of the patient and their symptoms.
- Components of haemostasis
  - Endothelium
  - Platelets and red blood cells
  - Coagulation cascade
  - Fibrin formation
  - Fibrinolysis
The candidate will be required to have an understanding of:
- Bleeding Disorders:
  - Congenital
  - Acquired
- Clotting Disorders
  - Congenital
  - Acquired

f. Pathogenesis of Atherosclerosis
- Theories
- Response to Injury:
  - Haemodynamic
  - Lipoprotein oxidation
The candidate will be required to have an understanding of the natural history of vascular disease. This includes how the disease progresses and its effects upon individuals. For example questions such as the following must be considered:
  - Is the disease aggressive in all individuals?
  - Do all individuals become symptomatic and require treatment?
  - Will factors such as the following have an impact on outcomes:
    - Hereditary disposition
    - Coexisting diseases
    - Lifestyle

g. Aortoiliac And Femoropopliteal Occlusive Disease
- Incidence and prevalence
- Risk Factors
- Disease location
- Clinical manifestations
- Intermittent claudication
- Ischaemic ulceration and gangrene
- Ischaemic neuropathy
- Disuse atrophy
- Rest pain
- Non-invasive studies
- Ankle/brachial index
- Segmental pressures
- Plethysmography
- Treadmill exercise testing
- Duplex sonography
- Treatment
- Medical
- Changes to lifestyle
- Surgical (extra-anatomical bypass grafting)
- Intravascular stents
- Neovascular grafting
- Reperfusion syndrome

h. Aneurysmal Disease
- Definition
  - aneurysm
  - ectasia
  - arteriomegaly
- Thoracic
- Abdominal
- Visceral
- Aortoiliac
- Femoral/Popliteal
- Classification
  - true
  - false
  - fusiform
  - saccular
  - dissecting
  - mycotic
  - inflammatory
- Prevalence of aneurysms
- Sites of aneurysms
- Gender and family history
- Signs and symptoms
- Risk factors
- Imaging modalities
- Capabilities and limitations of duplex sonography
- Treatment

i. Atheromatous Embolisation
- Pathogenesis
- Clinical manifestations
  - skin
  - kidney
  - neurologic
  - cardiac
  - gastrointestinal

j. Extracranial Carotid Artery Disease
- Risk factors
- Incidence and prevalence
- Disease Location
- Cerebral haemodynamics
- Collateral pathways
- Clinical manifestations
  - Transient Ischaemic Attack (TIA)
  - reversible Ischaemic Neurologic Deficit (RIND)
  - stroke in evolution
  - completed stroke
• Amaurosis Fugax
• lacunar TIAs and stroke
• dissection
• embolic strokes

• Nonatherosclerotic disease of the cerebral vasculature
  o radiation injury
  o fibromuscular dysplasia
  o temporal arteritis
  o dissection
  o kinks and coils
  o Takayasu’s arteritis
  o carotid body tumours

• Imaging modalities
• Capabilities and limitations of duplex sonography
• Treatment
  o medical
  o surgical

k. Vertebrobasilar Disease
  • Clinical manifestations
  • Incidence and prevalence
  • Types of lesions
  • Differential diagnosis
  • Imaging studies
  • Treatment

l. Transcranial Doppler Sonography
  • Indications
  • Examinations techniques
  • Ultrasonic windows
  • Diagnostic parameters

m. Upper Extremity Arterial Disease
  • Atherosclerosis
  • Embolic disease
  • Subclavian steal syndrome
  • Thoracic outlet syndrome
    o neurogenic, venous, arterial
    o pathophysiology
    o signs and symptoms
    o differential diagnosis
    o nonimaging and imaging modalities
    o treatment

• Vasospastic Diseases
  o primary Raynaud’s Disease
  o secondary causes of Raynaud’s phenomenon
  o connective tissue diseases
  o Hypothenar hammer syndrome

• Clinical presentation of upper extremity diseases
• Testing modalities:
- Advantages
- Limitations

- Application and Interpretation of PPG waveforms, duplex techniques and the significance of bilateral arm blood pressures.

n. Visceral Ischemic Syndromes
- Incidence
- Mesenteric vascular anatomy and collateral pathways
- Pathophysiology of acute intestinal ischaemia
- Acute embolic mesenteric ischaemia
- Acute mesenteric artery thrombosis
- Mesenteric venous thrombosis
- Chronic mesenteric ischaemia
- Coeliac artery compression syndrome
- Imaging modalities
- Duplex sonography:
  - Capabilities
  - Limitations

o. Renovascular Disease
- Classification of disease
  - Atherosclerosis
  - Fibromuscular dysplasia
  - Renal artery aneurysms
  - Renal artery stenosis
  - Renal artery thrombosis/embolism
  - Pathogenesis of renovascular hypertension

- Renal Transplantation
- B-Mode signs of rejection
- Doppler analysis of signs of rejection
- Haemodialysis access
- Duplex sonography:
  - Capabilities
  - Limitations

p. Venous Disease
- Deep venous thrombosis
  - Pathology
  - Pathogenesis (Virchow’s Triad)
  - Predisposing risk factors
  - Diagnostic modalities
  - Differential diagnosis
  - Treatment:
    → Medical
    → Surgical
- Superior vena cava syndrome
- Varicose Veins
  - Incidence
  - Risk factors
  - Pathophysiology
  - Primary
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• Secondary imaging modalities
  o treatment

• Superficial thrombophlebitis
  o signs and symptoms
  o differential diagnosis
  o Trousseau's syndrome
  o Treatment

• Pulmonary embolism
  o incidence
  o predisposition
  o signs and symptoms
  o treatment

• Chronic venous insufficiency
  o pathophysiology
  o clinical findings
  o classification
  o non-invasive assessment
  o treatment

q. Lymphatic Disease
• Lymphoedema
  o essentials of diagnosis
  o signs and symptoms
  o primary
  o secondary
  o treatment

r. Portal Venous System
• Normal anatomy and flow characteristics
• Portal Venous hypertension
  o signs and symptoms
  o collateral flow
  o sonographic diagnosis
  o changes in portal vein flow with congestive cardiac failure
  o surgical portosystemic shunts
• Hepatic venous flow
• Liver transplants
• Inferior vena cava

s. Nonatherosclerotic Vascular Diseases and Conditions
Although in 90% of cases, atherosclerosis is the primary underlying disease of patients with peripheral vascular disease various other pathologies give rise to vascular conditions. The candidate needs to be familiar with these other pathologies and have an understanding of the symptoms and clinical findings.

• Inflammatory Conditions:
  o arteritis
  o Takayasu's arteritis
  o giant cell arteritis
  o polyarteritis nodosa
- hypersensitivity vasculitis
- Behcet’s disease
- Buerger’s disease

- Noninflammatory Conditions:
  - fibromuscular hyperplasia
  - Marfan syndrome
  - Ehlers - Danlos syndrome
  - abdominal aortic coarctation
  - adventitial cystic disease
  - popliteal artery entrapment
  - compartment syndromes
  - persistent sciatic artery

The candidate will also be required to have an understanding of:
- Diabetic foot lesions
- vasculogenic impotence
- Arteriovenous malformations and fistulae
- Vascular tumours
- Peripheral vascular disease in children
- Vascular trauma
- Reflex sympathetic dystrophy
- Diagnosis and treatment of lipid disorders
- Anticoagulants and antithrombotic agents

u. Professional, Legal and Ethical Aspects of Sonographic Practice
The role of the sonographer is diverse and complex and so DMU candidates are required to have an understanding of their responsibilities to the:
- patient
- employer
- regulating bodies

Candidates must also understand and adopt practices that conform to the standards of their profession and have due consideration for the legal and ethical issues which regulate their actions as a health care professional.

Sonographers must be aware of their legal responsibilities and of ethical issues that may occur during their practice as a sonographer. The candidate is expected to have an understanding about a range of legal issues including:
- consent
  - verbal
  - written
  - implied
  - competence to give consent
- patient confidentiality
- record keeping
  - maintaining confidentiality
  - storage of records
- a sonographer’s legal responsibilities

Sonographers must be aware of:
- published standards of practice
- the process of sonographer accreditation
- the value of membership to appropriate professional bodies
The candidate is also expected to have a good knowledge of these workplace issues:
- workplace health and safety including ergonomics
- emergency procedures
- infection control
  - policies
  - procedures
- quality control of equipment
- administrative processes
- indemnity insurance

The candidate must also have an understanding of the following ethical aspects of sonography:
- basic bioethical principles and how they apply to sonography
- autonomy
- non-maleficence
- beneficence
- justice
- veracity
- how to resolve ethical dilemmas and conflict
- the relevance of bioethics in the practice of sonography and in particular in:
  - obstetrics and gynaecology
  - the use of new technologies

In order to be able to critically analyse information and understand their responsibilities you will need to:
- read widely from relevant publications
- attend conferences and seminars
- participate in continuing education programs

**NOTE:** It is each candidate’s responsibility to ensure that they have covered all the areas in this syllabus using all the resources available to them.