Point of Care Ultrasound Curriculum for MMED Anaesthesia – V5.0

Scope

Knowledge and practical skills of the following POCUS applications** can be examined in the MMED Anaesthesia Examination:

1. Definition, Benefits, Indications and Limitations
2. Infection Control, Care of Probes and Machines
3. Basic Ultrasound Physics and Knobology
4. Cardiac Point of Care Ultrasound (Focused Cardiac Ultrasound / FATE)
5. Lung Ultrasound
6. Gastric Ultrasound
7. Airway Ultrasound

The components under **"Essential Knowledge and Skills" can be examined in MMED anaesthesia.

The components under **"Good to Know"** are not examined in MMED anaesthesia. They are considered intermediate level to advanced level knowledge and skills for point of care ultrasound.

<table>
<tr><th colspan="3">Focused Cardiac Ultrasound</th></tr>
<tr><td>Indications</td><td colspan="2">

Unexplained Perioperative Hypotension
Chest Pain
Dyspnoea / SOB
Pre-op Evaluation
Cardiac Arrest

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<tr><td>Acquisition</td><td colspan="2">

Patient Position

Left Lateral Decubitus (if stable)
Supine (if unstable or on OT table)
30º head up (if in ICU/ward/induction room/PACU)

Probe

Phased Array Probe (IVC/Heart)
Orientation Marker as per Standard Echo Protocol

Picture

Appropriate Depth and Gain Settings

Protocol

PLAX
PSAX Mid-Papillary View
Apical 4 Chamber
Subcostal 4 Chamber
Subcostal IVC transverse and longitudinal views

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<tr><td>Interpretation</td><td>Essential Knowledge and Skills

Identify all cardiac structures and chambers in all views, including LV walls.
Qualitative assessment of chamber sizes – Able to say that the LV or RV is grossly dilated.
Qualitative assessment of LV and RV wall thickness. Can identify gross hypertrophy.
Qualitative evaluation of LV systolic function – Visual LVEF (Normal, mild to moderate vs severe LV systolic failure). Able to differentiate normal LV systolic function from severe LV systolic failure.
Identify obvious RWMA – e.g. Akinesia/Dyskinesia

</td><td>Good to Know:

Advanced views – e.g. PSAX at various levels, A3C, A5C, A2C
Quantify LV and RV chamber sizes. Able to perform chamber size measurements in 2D/M-Mode.
Quantification: Able to measure LV and RV wall thickness. 2D or M-Mode
Identify RWMA
Quantification of LV systolic function: Fractional Shortening, Fractional Area Change, EPSS, MAPSE, Stroke Volume Measurement.
Quantification of RV function: TAPSE

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	• Qualitative evaluation of RV function. Can recognise gross RV dilatation, RV failure, McConnell's sign, interventricular septal shifts. • Identify causes of SHOCK / Cardiac Arrest: POCUS features of Hypovolaemic, Cardiogenic, Obstructive & Distributive Shock.	• Protocols – e.g. RUSH Protocol or FAST Scan in trauma

	• **Volume Responsiveness**
	  ○ IVC: Qualitative & quantitative assessment of IVC calibre.
	  ○ Able to measure vessel size and identify respiratory variation.
	  ○ End diastolic size of LV
	  ○ Kissing LV
		• **Volume Responsiveness**
		  ○ IVC Collapsibility / Distensibility Index
		  ○ IJV Evaluation
		  ○ Aortic Flow Variability (LVOT VTI)

	• **Cardiac Tamponade**
	  ○ Can identify pericardial effusion – global vs localised, size of effusion.
	  ○ Identify 2D features of cardiac tamponade: e.g. systolic RA and diastolic RV collapse, plethoric IVC.
		• **Cardiac Tamponade**
		  ○ Quantify size of pericardial effusion
		  ○ Identify septal bounce.
		  ○ Ventricular size variability with respiratory cycle
		  ○ Identify mitral and tricuspid transvalvular inflow variability with respiration.

	• **Pulmonary Embolism**
	  ○ Identify RV dilatation
	  ○ Septal wall flattening / D shaped septum
	  ○ Plethoric IVC
	  ○ McConnell's Sign
	  ○ Clot in transit
		• **Pulmonary Embolism**
		  ○ RV/LV Ratio
		  ○ TR
		  ○ Reduced TAPSE
		  ○ 60/60 sign
		  ○ PA mid systolic notching

	• Aortic Dissection – Able to identify a dissection flap in the PLAX view, descending aorta, or abdominal aorta.	
	• Gross valvular pathology: e.g. - 2D features of severe AS	• Able to identify other valvular pathology and quantify degrees of stenosis or regurgitation using colour doppler / CWD / PWD

Management	Appropriate clinical management, integrating POCUS findings with the clinical scenario Example Scenarios: Perioperative Hemodynamic Instability, Hypotensive Patient Presenting for Emergency Surgery

Lung Ultrasound	
Indications	● Diagnostic Applications ○ Differentiating clinical signs: wheeze (bronchospasm vs pulmonary oedema); crackles (pulmonary oedema vs pneumonia/ARDS vs interstitial lung disease); reduced breath sounds (pneumothorax, effusion, lobar/total lung collapse, consolidation, atelectasis, diaphragmatic elevation) ○ Differentiating CXR opacities (effusion vs consolidation) ○ Suspected Pneumothorax, Pleural Effusion, Consolidation, or Diaphragm dysfunction ● Monitoring / Prognostication ○ Monitoring fluid administration or diuresis/RRT ○ Mechanical Ventilation - Weaning / Recruitment ○ Disease Progression – Effusion Size, Lung Re-Expansion etc. ○ Decision whether pleural drain required for pneumothorax or effusion.
Acquisition	● Patient Position ○ Supine (if unstable or on OT table) ○ 30^{o} head up (if in ICU/ward/induction room/PACU) ● Probe ○ Linear Probe – Pleural motion, lung point, and pleural line abnormalities ○ Curvilinear / Phased Array – Lung Parenchyma, Posterior Lungs, Supra-Diaphragmatic Lungs ○ Orientation – Marker Cephalad (left of screen cephalad, right of screen caudad) or Towards Patient's Right. ● Picture ○ Anterolateral (2D and M-Mode) ▪ Longitudinal (Vertical) image orientation, identify ribs, intercostal spaces, pleural line, lung parenchyma. ○ Posterior Basal (2D) ▪ Longitudinal (Vertical) image orientation, Identify Diaphragm position and junction of chest/abdomen, Liver/Spleen below diaphragm, Lung Parenchyma above diaphragm, Spine. ○ Diaphragm excursion: subcostal view + M-mode bilaterally. ● Protocol ○ Pleural sliding & pleural line abnormalities: MCL & MAL bilaterally ○ Lung point: infraclavicular to midaxillary oblique scan as for PECS2 & SAP block bilaterally ○ Lung pathology/effusion: 3 Blue Points (MCL, MAL, PAL) bilaterally

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<tr><td>Interpretation</td><td>Essential Knowledge and Skills
2D and M-Mode Lung Ultrasound Signs
Normal Lung Ultrasound Findings: Lung Sliding, Lung Pulse, A Lines, Curtain Sign, Seashore Sign.
Pathology:
Understand the implications of finding absent lung sliding. It is not diagnostic of pneumothorax.
Pneumothorax: Absent lung sliding, absent lung pulse, lung point, barcode sign.
Interstitial oedema: B-lines
Subpleural / lobar consolidation
Lung hepatization
Pleural effusion: Spine sign, jellyfish sign
Pleural effusion drainage: size > 5cm at PAL/MAL + respiratory/haemodynamic compromise</td><td>Good to Know
B-Lines – Differentiate ARDS vs Pulmonary Oedema
Scoring Systems
Decision trees:
BLUE protocol: respiratory failure differentiation
FALLS protocol, reverse FALLS protocol: Fluid/diuretic management
ICU Related Lung Ultrasound
Weaning/Extubation/Recruitment: Correlate with adverse clinical features (RSBI, CXR, gas exchange, respiratory mechanics, haemodynamics, acute cor pulmonale risk score)
During weaning/SBT/post-extubation: exclude worsening B-lines (derecruitment vs weaning induced pulmonary oedema - WIPO = Fluid overload vs HFpEF vs HFrEF vs NPPO) ; diaphragm elevation/reduced excursion (visual estimate) ; cardiac dysfunction ; fluid overload
During recruitment (NB US cannot detect lung overdistension): exclude pneumothorax, wheeze, auto PEEP, cardiac dysfunction, fluid overload, acute RVF (acute cor pulmonale risk score for ARDS) look for improving B-lines or consolidation with PEEP or prone positioning</td></tr>
<tr><td>Management</td><td colspan="2">Appropriate clinical management, integrating POCUS findings with the clinical scenario

Example Scenarios: Post operative dyspnoea in PACU, Desaturation and SOB following supraclavicular block.</td></tr>
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<table>
<tr><th colspan="3">Gastric Ultrasound</th></tr>
<tr><td>Indications</td><td colspan="2">

Diagnostic Applications

Identify Risk of Aspiration
Unknown Fasting Times
Emergency Surgery
Patients with Delayed Gastric Emptying

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<tr><td>Acquisition</td><td colspan="2">

Patient Position

Right Lateral Decubitus (RLD) and Supine

Probe

Curvilinear Probe
Sagittal Scan Plane

Picture

Identify Gastric Antrum at the Level of the Aorta
Cross-Sectional Area of Gastric Antrum
Contents of Gastric Antrum

Protocol

Supine Followed by RLD

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<tr><td>Interpretation</td><td>Essential Knowledge and Skills

Nature of Gastric Contents

Empty
Clear Fluid – Low vs High Gastric Volume
Thickened Fluid / Solids / Air

</td><td>Good to Know

Volume Estimation

CSA and Volume Estimation – (<1.5ml/kg vs > 1.5ml/kg)

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<tr><th colspan="3">Airway Ultrasound</th></tr>
<tr><td>Indications</td><td colspan="2">● Identification of CTM
● Confirm Endotracheal Intubation, DLT/Bronchial blocker placement
● Rule Out Oesophageal Intubation and endobronchial intubation</td></tr>
<tr><td>Acquisition</td><td colspan="2">● Patient Position
○ Supine
● Probe
○ Linear Probe
● Picture
○ Longitudinal and Transverse Scan
● Protocol
○ Transverse scan sliding from thyroid cartilage to cricoid cartilage and back to CTM (TACA technique)
○ Midsagittal scan over the thyroid and cricoid cartilages with hyperechoic CTM in between
○ Transverse scan over trachea at suprasternal notch, with gentle ETT manipulation to accentuate movement
○ Scan both sides of chest for bilateral lung sliding</td></tr>
<tr><td>Interpretation</td><td>Essential Knowledge and Skills
● Locating the level, mid-point and size of CTM</td><td>Good to Know
• Movement of glottic structures as tube passes trachea.
• “Bullet” sign for tracheal and “double tract” sign for oesophageal intubation
• DLT position confirmation</td></tr>
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</table>

References:

1. I-AIM A Novel Model for Teaching and Performing Focused Sonography. Bahner et al. J Ultrasound Med 2012; 31:295–300

2. Focused Cardiac Ultrasonography. Spencer et al. JACC: Cardiovascular Imaging; 2019; (12): 7: 1243-1253

3. AIM (Indication, Acquisition, Interpretation, Medical Decision-making) Framework for Point of Care Lung Ultrasound. Kruisselbrink et al. Anesthesiology; 2017;(127): 568-582.

4. I-AIM framework for point-of-care gastric ultrasound. Perlas et al. British Journal of Anaesthesia; 2016; 116 (1): 11–13

5. POCUS Spotlight: Airway Ultrasound. Kolli et al. ASRA News. 2021;46. https://doi.org/10.52211/asra080121.046.