Ultrasound for the Generalist

A Guide to Point-of-Care Imaging

Edited by

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Digital media accompanying book can be accessed online via the code printed on the inside of the cover
Foreword

It is a pleasure and a privilege to write a foreword and contribute to this unique ultrasound field book. From the clinician just starting out on their point-of-care ultrasound (POCUS) journey to those who are already established and well advanced, this book will prove to be an invaluable companion. The increasingly recognised value of POCUS for all clinical decision-making means that this book will appeal to General Practitioners, Family Medicine Physicians, Emergency, Acute and Critical Care Physicians, Paramedics and Prehospital Practitioners, Physiotherapists, Podiatrists and Advanced Nurse Practitioners.

Ultrasound for the Generalist – A Guide to Point-of-Care Imaging provides you with the knowledge and skills to learn the basics and progress to develop more advanced skills. You will understand how ultrasound images are created, how to acquire and interpret them for each organ and to apply them in your daily work. You will learn what is normal and what is abnormal in the context of real cases and appreciate the importance of quality assurance, limitations and accreditation. The combination of digital media and case descriptions brings this book alive and will inspire you to reach for the scanner. This is an ideal book to take out with you in your field of clinical work as a real-time reference guide.

Ultrasound for the Generalist definitely addresses the needs of the generalist as it covers a wide range of organ systems where POCUS informs management decisions. Chapters range from thoracic ultrasound and echocardiography through to gynaecological and musculoskeletal ultrasound and considers new care settings where even experienced POCUS users may not have seen ultrasound at the bedside. The coverage of remote and austere medicine, including prehospital, military and humanitarian medicine, highlights the essential diagnostic role of POCUS in resource-limited settings.

As a senior clinician, POCUS has enabled me to deliver and practice the best clinical medicine of my career. It has empowered me with a skill that provides prompt and accurate information to make decisions wherever I see patients – in the home, care home or in the hospital. It has been a complete ‘game changer’ in my day-to-day practice as I have been able to deliver more acute care within community settings. This has been critical for the development of Acute Hospital at Home so that patients and families have a more credible choice over where they would like to be treated during an acute illness. POCUS is now a routine part of my assessment of patients.

I have worked alongside the authors Dr Sarb Clare and Dr Chris Duncan for a number of years and am really proud to have them as my colleagues. Their dedication, clinical expertise and passion for POCUS is inspirational and contagious. All clinical cases within this book are original and display the extensive experience of the authors and contributors.

I highly recommend this very special book for all generalists. It is beautifully written for the learner and easy to follow with fantastic illustrations, scans, photos and digital media. This indispensable text will allow you to acquire and apply this increasingly critical skill to provide the highest quality of care to all patients you see and in whatever setting you see them.

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Clinical Lead, Hospital at Home, Oxford University Hospitals NHS Foundation Trust, UK
Twitter @DanLasserson
2021
Preface

Point-of-care ultrasound (POCUS) has become an essential tool within acute specialties to enhance bedside diagnostics, facilitate safe interventional procedures and guide referral to specialist services. It is vital for this tool to be expanded to community and prehospital settings where access to definitive investigations is limited. With the evolution of technology, ultrasound is becoming increasingly available due to reducing costs, machine size and remote image review for quality assurance purposes. This skill is invaluable for clinicians at all levels of training from medical school through to consultancy and allied healthcare professionals in any discipline.

With extensive experience using POCUS and seeing the uncountable benefits from swift diagnoses, streamlining the patient journey, carrying out safe procedures and ultimately saving lives, we are both hugely passionate about sharing this skill with all generalist colleagues. We were inspired to write *Ultrasound for the Generalist* – *A Guide to Point-of-Care Imaging* to provide a field handbook with the fundamentals and foundation of knowledge for clinicians to apply to whatever their normal practice may be.

It is only once you start using ultrasound in day-to-day practice that you will see and appreciate its true utility. US is a simple skill to acquire and yet it confers huge benefits for patients. It will enhance your clinical decision-making and identify pathology you would previously wait days or weeks to confirm. We are very keen to hear from you when you scan the cardinal case where ultrasound makes the difference!

This book will teach you how to use the machine, acquire images, recognise key anatomical landmarks and the appearance of pathology. You will learn to scan all systems and how to achieve competency and accreditation. It starts with the basics and progresses beyond conventional POCUS accreditation pathways. We have complemented the chapters with examples from our extensive library of real-life patient cases.

Key areas of inclusion are the application of US within ‘Hospital at Home’, Palliative Care, Soft tissue and Musculoskeletal, COVID-19 and Remote, Austere, Military and Humanitarian medicine. US does not ‘belong’ to any one specialty and clinicians should identify and incorporate the techniques applicable to their daily practice.

We would like to thank all our mentors and the POCUS enthusiasts championing this skill. A massive thanks to our contributing authors and the publishers at Cambridge University Press, in particular Catherine Barnes and Kim Ingram, for believing in us and our vision. Final thanks to our family and friends for their relentless support!

Enjoy the read and please spread the Power of POCUS!

**Dr Sarb Clare and Dr Chris Duncan**

2021


This book provides access to an online version on Cambridge Core, which can be accessed via the code printed on the inside of the cover.
Abbreviations

A2C apical two-chamber view
A3C apical three-chamber view
A4C apical four-chamber view
A5C apical five-chamber view
AAA abdominal aortic aneurysm
ACA anterior cerebral artery
AF atrial fibrillation
AFB acid fast bacilli
AIM acute internal medicine
ALI acute lung injury
AMVL anterior mitral valve leaflet
Ao aorta
AP anterior-posterior
AMS acute mountain sickness
AR aortic regurgitation
ARDS acute respiratory distress syndrome
ARVC arrhythmogenic right ventricular cardiomyopathy
AS aortic stenosis
ASD atrial septal defect
ASE American Society of Echocardiography
ATT anti tubercular treatment
AV aortic valve
AXR abdominal X-ray
BLUE basic lung ultrasound examination
BP blood pressure
BSE British Society Of Echocardiography
CAP community-acquired pneumonia
CBD common bile duct

CFM colour flow mode
CKD chronic kidney disease
CO cardiac output
COPD chronic pulmonary obstructive disease
CPAP continuous positive airway pressure
CPD continual professional development
CPR cardiopulmonary resuscitation
CRP C-reactive protein
CRL crown rump length
CT computed tomography
CTPA computed tomography pulmonary angiogram
CW continuous wave
CWD continuous wave Doppler
CXR chest X-ray
dBs decibels
DC direct current
DCM dilated cardiomyopathy
DCS decompression stress
DICOM digital imaging and communications in medicine
DVT deep vein thrombosis
EBV Epstein–Barr virus
ECG electrocardiogram
Echo echocardiogram
ECMO extracorporeal membrane oxygenation
ED emergency department
EF ejection fraction
EM emergency medicine
### Abbreviations

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
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<tbody>
<tr>
<td>ESR</td>
<td>erythrocyte sedimentation rate</td>
</tr>
<tr>
<td>EtCO2</td>
<td>end tidal carbon dioxide</td>
</tr>
<tr>
<td>ETT</td>
<td>endotracheal tube</td>
</tr>
<tr>
<td>FAC</td>
<td>fractional area change</td>
</tr>
<tr>
<td>FASH</td>
<td>focused assessment sonography HIV-associated tuberculosis</td>
</tr>
<tr>
<td>FAST</td>
<td>focused assessment with sonography in trauma</td>
</tr>
<tr>
<td>e-FAST</td>
<td>extended focused assessment with sonography in trauma</td>
</tr>
<tr>
<td>FB</td>
<td>foreign body</td>
</tr>
<tr>
<td>FH</td>
<td>frank hypovolaemia</td>
</tr>
<tr>
<td>FUSIC</td>
<td>focused intensive care echocardiography</td>
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<tr>
<td>GB</td>
<td>gallbladder</td>
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<td>GCA</td>
<td>giant cell arteritis</td>
</tr>
<tr>
<td>GCS</td>
<td>Glasgow Coma Scale</td>
</tr>
<tr>
<td>GP</td>
<td>general practitioner</td>
</tr>
<tr>
<td>HACE</td>
<td>high altitude cerebral oedema</td>
</tr>
<tr>
<td>HAPE</td>
<td>high altitude pulmonary oedema</td>
</tr>
<tr>
<td>HAPH</td>
<td>high altitude pulmonary hypertension</td>
</tr>
<tr>
<td>HCG</td>
<td>human chorionic gonadotropin</td>
</tr>
<tr>
<td>HCM</td>
<td>hypertrophic obstructive cardiomyopathy</td>
</tr>
<tr>
<td>HIV</td>
<td>human immunodeficiency virus</td>
</tr>
<tr>
<td>HPB</td>
<td>hepatobiliary</td>
</tr>
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<td>HRCT</td>
<td>high resolution computed tomography</td>
</tr>
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<td>HTN</td>
<td>hypertension</td>
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<td>Hz</td>
<td>Hertz</td>
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<tr>
<td>IAS</td>
<td>interatrial septum</td>
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<tr>
<td>ICD</td>
<td>intercostal drain</td>
</tr>
<tr>
<td>ICP</td>
<td>intracranial pressure</td>
</tr>
<tr>
<td>ICU</td>
<td>intensive care unit</td>
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<tr>
<td>IHH</td>
<td>idiopathic intracranial hypertension</td>
</tr>
<tr>
<td>ITU</td>
<td>intensive therapy unit</td>
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<tr>
<td>IVC</td>
<td>inferior vena cava</td>
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<tr>
<td>IV</td>
<td>intravenous</td>
</tr>
<tr>
<td>IVDU</td>
<td>intravenous drug user</td>
</tr>
<tr>
<td>IVF</td>
<td>in vitro fertilisation</td>
</tr>
<tr>
<td>JVP</td>
<td>jugular venous pressure</td>
</tr>
<tr>
<td>KHz</td>
<td>Kiloohertz</td>
</tr>
<tr>
<td>LA</td>
<td>left atrium</td>
</tr>
<tr>
<td>LBBB</td>
<td>left bundle branch block</td>
</tr>
<tr>
<td>LP</td>
<td>lumbar puncture</td>
</tr>
<tr>
<td>LUQ</td>
<td>left upper quadrant</td>
</tr>
<tr>
<td>LUS</td>
<td>lung ultrasound</td>
</tr>
<tr>
<td>LV</td>
<td>left ventricle</td>
</tr>
<tr>
<td>LVAS</td>
<td>left ventricular assist system</td>
</tr>
<tr>
<td>LVEDP</td>
<td>left ventricular end diastolic pressure</td>
</tr>
<tr>
<td>LVIDd</td>
<td>left ventricle internal diameter in diastole</td>
</tr>
<tr>
<td>LVIDs</td>
<td>left ventricle internal diameter in systole</td>
</tr>
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<td>LVH</td>
<td>left ventricular hypertrophy</td>
</tr>
<tr>
<td>LVNCC</td>
<td>left ventricular non compaction cardiomyopathy</td>
</tr>
<tr>
<td>LVOT</td>
<td>left ventricular outflow tract</td>
</tr>
<tr>
<td>LVOTO</td>
<td>left ventricular outflow tract obstruction</td>
</tr>
<tr>
<td>LVPWD</td>
<td>left ventricle posterior wall in diastole</td>
</tr>
<tr>
<td>m/s</td>
<td>metres per second</td>
</tr>
<tr>
<td>MAPSE</td>
<td>mitral annular plane systolic excursion</td>
</tr>
<tr>
<td>MCA</td>
<td>middle cerebral artery</td>
</tr>
<tr>
<td>MDR TB</td>
<td>multi drug resistant tuberculosis</td>
</tr>
<tr>
<td>MERT</td>
<td>medical emergency response team</td>
</tr>
<tr>
<td>MHz</td>
<td>Megahertz</td>
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<tr>
<td>MI</td>
<td>myocardial infarction</td>
</tr>
<tr>
<td>M-Mode</td>
<td>motion mode</td>
</tr>
<tr>
<td>MPA</td>
<td>main pulmonary artery</td>
</tr>
<tr>
<td>MR</td>
<td>mitral regurgitation</td>
</tr>
<tr>
<td>MRI</td>
<td>magnetic resonance imaging</td>
</tr>
<tr>
<td>MS</td>
<td>mitral stenosis</td>
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Abbreviations

- **MSK** musculoskeletal
- **MSKUS** musculoskeletal ultrasound
- **MSSA** methicillin susceptible staphylococcus aureus
- **MV** mitral valve
- **NF** necrotising fasciitis
- **NHS** National Health Service
- **NICE** National Institute of Clinical Excellence
- **NSTEMI** non ST elevation myocardial infarction
- **NYHA** New York Health Association
- **ON** optic nerve
- **ONSD** optic nerve sheath diameter
- **PA** pulmonary artery
- **PACS** picture archive and communication systems
- **PCA** posterior cerebral artery
- **PCI** percutaneous coronary intervention
- **PD** power Doppler
- **PE** pulmonary embolism
- **PEA** pulseless electrical activity
- **PEEP** positive end expiratory pressure
- **PG** porcelain gallbladder
- **PHEM** prehospital emergency medicine
- **PHT** pulmonary hypertension
- **PHUS** prehospital ultrasound
- **PIMS** paediatric multisystem inflammatory syndrome
- **PLAPS** posterolateral alveolar and/or pleural syndrome
- **PLAX** parasternal long-axis view
- **PMVL** posterior mitral valve leaflet
- **POCUS** point-of-care ultrasound
- **POD** Pouch of Douglas
- **PSAX** parasternal short-axis view
- **PSS** Paget-Schroetter syndrome
- **PV** pulmonary valve
- **PW** pulse wave
- **PWD** pulse wave Doppler
- **QA** quality assurance
- **RA** right atrium
- **RBBB** right bundle branch block
- **RCEM** Royal College of Emergency Medicine
- **RCR** Royal College of Radiologists
- **REBOA** resuscitative endovascular balloon occlusion of the aorta
- **RHD** rheumatic heart disease
- **ROSC** return of spontaneous circulation
- **RUQ** right upper quadrant
- **RV** right ventricle
- **RVESA** right ventricular end systolic area
- **RVID** right ventricular internal dimension
- **RVOT** right ventricular outflow tract
- **RWMA** regional wall abnormalities
- **SAH** subarachnoid haemorrhage
- **SAM** systolic anterior motion
- **SBE** subacute bacterial endocarditis
- **SC** subcostal view
- **SFJ** saphenofemoral junction
- **SLE** systemic lupus erythematosus
- **SMA** superior mesenteric artery
- **SOB** shortness of breath
- **SS** suprasternal view
- **STIs** sexually transmitted infections
- **STEMI** ST elevation myocardial infarction
- **SV** stroke volume
- **TAB** temporal artery biopsy
- **TAP** transversus abdominis plane
- **TAPSE** tricuspid annular plane systolic excursion
- **TAUS** temporal artery ultrasound
- **TB** tuberculosis
- **TCD** transcranial Doppler
<table>
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<tr>
<th>Abbreviation</th>
<th>Description</th>
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<tbody>
<tr>
<td>TDI</td>
<td>tissue Doppler imaging</td>
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<tr>
<td>THI</td>
<td>tissue harmonic imaging</td>
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<tr>
<td>TGC</td>
<td>time gain compensation</td>
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<tr>
<td>TOE</td>
<td>transoesophageal echocardiography</td>
</tr>
<tr>
<td>TR</td>
<td>tricuspid regurgitation</td>
</tr>
<tr>
<td>TTE</td>
<td>transthoracic echocardiography</td>
</tr>
<tr>
<td>TV</td>
<td>tricuspid valve</td>
</tr>
<tr>
<td>TVUS</td>
<td>transvaginal ultrasound</td>
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<tr>
<td>UGRA</td>
<td>ultrasound guided regional anaesthesia</td>
</tr>
<tr>
<td>US</td>
<td>ultrasound</td>
</tr>
<tr>
<td>USS</td>
<td>ultrasound scan</td>
</tr>
<tr>
<td>UTI</td>
<td>urinary tract infection</td>
</tr>
<tr>
<td>VATS</td>
<td>video assisted thoracoscopic surgery</td>
</tr>
<tr>
<td>VEXUS</td>
<td>venous excess ultrasound</td>
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<tr>
<td>VGE</td>
<td>venous gas emboli</td>
</tr>
<tr>
<td>V/Q</td>
<td>ventilation and perfusion</td>
</tr>
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<td>VSD</td>
<td>ventricular septum defect</td>
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<td>VTE</td>
<td>venous thromboembolism</td>
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<td>VTI</td>
<td>velocity time integral</td>
</tr>
<tr>
<td>VUJ</td>
<td>vesicoureteric junction</td>
</tr>
<tr>
<td>WES</td>
<td>wall echo shadow</td>
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<tr>
<td>WHO</td>
<td>World Health Organization</td>
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</table>
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