Cardiology

CLINICAL CASES UNCOVERED

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To my wife, Mags, for her patience. TB

To my parents for their lifelong support. JD

To my father, for his constant love and support. SB

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Preface

Although there are many books already published on the subject of cardiovascular medicine, we felt that there was nothing that offered medical students and junior doctors a practical, patient-based approach. This book has been written to fill that gap. It is suitable for students, trainees in general internal medicine, general practice and budding cardiologists.

It provides a concise resume of the key features of anatomy and physiology that have direct clinical applications when investigating and treating patients with cardiac disease. By presenting 'real world' examples in 26 case scenarios, all the common (and some uncommon) cardiac diagnoses are revealed. Particular emphasis is placed on history taking, the interpretation of physical signs and the appropriate use of non-invasive and invasive investigations. Arguments for and against differential diagnoses are discussed. Treatment options are explained in detail and the impact of cardiovascular disease on prognosis, lifestyle and genetic screening is explored. Throughout the text, key points and red flags are highlighted and learning points are summarized at the end of each case. High-quality reproductions of electrocardiograms, echocardiograms and other imaging modalities have been included to simulate the real patient encounter.

Three self-assessment sections have been written in the format of commonly-used examination methods. The questions stem from the clinical cases, yet add an additional layer of education and information for the reader.

We hope this book acts as a stepping stone from traditional cardiology texts to the application of knowledge in the clinical world. As well as being a reference and assessment tool, it should above all be an enjoyable read that can be dipped in and out of or read from cover to cover in one go. We hope it inspires the next generation of cardiologists!

Tim Betts
Jeremy Dwight
Sacha Bull
Oxford

How to use this book

Clinical Cases Uncovered (CCU) books are carefully designed to help supplement your clinical experience and assist with refreshing your memory when revising. Each book is divided into three sections: Part 1, Basics; Part 2, Cases; and Part 3, Self-assessment.

Part 1 gives you a quick reminder of the basic science, history and examination, and key diagnoses in the area. Part 2 contains many of the clinical presentations you would expect to see on the wards or crop up in exams, with questions and answers leading you through each case. New information, such as test results, is revealed as events unfold and each case concludes with a handy case summary explaining the key points. Part 3 allows you to test your learning with several question styles (MCQs, EMQs and SAQs), each with a strong clinical focus.

Whether reading individually or working as part of a group, we hope you will enjoy using your CCU book. If you have any recommendations on how we could improve the series, please do let us know by contacting us at: medstudentuk@oxon.blackwellpublishing.com.

Disclaimer

CCU patients are designed to reflect real life, with their own reports of symptoms and concerns. Please note that all names used are entirely fictitious and any similarity to patients, alive or dead, is coincidental.

List of abbreviations

AICD	automated implantable cardioverter-defibrillator
ACE	angiotensin-converting enzyme
ACS	acute coronary syndrome
A&E	Accident & Emergency
AHA	American Heart Association
ALT	alanine aminotransferase
AR	aortic regurgitation
AS	aortic stenosis
ASD	atrial septal defect
AV	atrioventricular
AVA	aortic valve area
AVNRT	atrioventricular nodal re-entrant tachycardias
AVRT	atrioventricular re-entrant
BMI	body mass index
BNP	brain natriuretic peptide
bpm	beats per minute
CCU	Coronary Care Unit
COPD	chronic obstructive airways disease
CPAP	continuous positive airways pressure
CPR	cardiopulmonary resuscitation
CT	computer tomography
CTR	cardiothoracic ratio
CVP	central venous pressure
Cx	circumflex
CXR	chest X-ray
DC	direct current
DVLA	Driver and Vehicle Licensing Agency
DVT	deep vein thrombosis
ESR	erythrocyte sedimentation rate
FBC	full blood count
FEV_1	forced expiratory volume in 1 s
FVC	forced vital capacity
GFR	glomerular filtration rate
GGT	gamma-glutamyl transpeptidase
GI	gastrointestinal
GP	general practitioner
GTN	glyceryl trinitrate
Hb	haemoglobin
HDL	high-density lipoprotein
HFNEF	heart failure normal ejection fraction
HGV	heavy goods vehicle
HIV	human immunodeficiency virus
HOCM	hypertrophic obstructive cardiomyopathy
ICD	implantable cardioverter defibrillator
ICU	Intensive Care Unit
INR	international normalised ratio
IVAB	intravenous antibiotics
JVP	jugular venous pressure
LAD	left anterior descending
LBBB	left branch bundle block
LCA	left coronary artery
LCx	left circumflex
LDH	lactate dehydrogenase
LDL	low-density lipoprotein
LMS	left main stem
LQTS	long-QT syndrome
LVEF	left ventricular ejection fraction
LVH	left ventricular hypertrophy
MCV	mean corpuscle volume
MEN	multiple endocrine neoplasia
MIBG	metaiodobenzylguanidine
MR	mitral regurgitation
MRI	magnetic resonance imaging
MS	mitral stenosis
MUGA	multi-gated acquisition
MCV	mean corpuscle volume
NICE	National Institute for Health and Clinical Excellence
NYHA	New York Heart Association
PCI	percutaneous coronary intervention
PDA	patent ductus arteriosus
PEA	pulseless electrical activity
PFO	patent foramen ovale
PV	pulmonary valve
RBBB	right branch bundle block
RCA	right coronary artery

rtPA	recombinant tissue plasminogen activator
rPA	reteplase
SA	sinoatrial
SCD	sudden cardiac death
STEMI	ST-elevation myocardial infarction (also non-STEMI)
SVT	supraventricular tachycardia
TB	tuberculosis
TC	total cholesterol
TIA	transient ischaemic attack
TIMI	thrombolysis in myocardial infarction
TNK	tenecteplase
TS	tricuspid stenosis
TR	tricuspid regurgitation
tPA	tissue plasminogen activator
TR	tricuspid regurgitation
VPC	ventricular premature contraction
VSD	ventricular septal defect
VVIR	ventricular inhibited rate responsive
WCC	white cell count

Basic science

Anatomy

The primary function of the heart is to pump deoxygenated blood to the lungs and to return oxygenated blood to the rest of the body. The basic anatomy consists of:

- Pericardium (visceral and parietal): the fibrous sac containing the heart.
- Four cardiac chambers: the right and left atria and ventricles.
- Heart valves:
  - Two outflow valves: the aortic and pulmonary valves consist of three semi-lunar cusps.
  - Two atrioventricular (AV) valves: the mitral and tricuspid valves, which are attached by chordae tendinae to papillary muscles.
- Vascular system:
  - Great vessels: the pulmonary artery, pulmonary vein and aorta.
  - Three main coronary arteries: the left anterior descending (LAD) and circumflex (Cx) arteries, which originate from the left main stem (LMS) and the right coronary artery (RCA).
  - Venous system: the venous blood is drained via the great cardiac vein, small anterior cardiac vein and thesbian veins.
- Electrical conducting system, which consists of specialised cells that are able to depolarise spontaneously (*automaticity*) forming:
  - The sinoatrial (SA) node.
  - The atrioventricular node.
  - The Bundle of His (right and left) and terminal Purkinje fibres.

The foetal heart

A knowledge of basic cardiac embryology is helpful for understanding how lesions found in adult congenital heart disease develop.

Foetal atria and ventricles (Figure A)

The heart begins life as a primitive tube, which folds to produce early cardiac chambers: the sinus venosus, the primitive atrium, the ventricle and the bulbus cordis. Further separation of the chambers occurs as follows:

- A pair of septa, the *septum primum* and *septum secundum*, grow to separate the right and left atria. The septum primum fuses with the endocardial cushions, the septum secundum does not. The free edge of the septum primum and secundum form the *foramen ovale*.
- A muscular interventricular septum grows from the floor of the common ventricle to divide it into two chambers.

Foetal shunts (Figure B)

The lungs are bypassed in the foetal circulation by the following right to left shunts:

- *Foramen ovale:* oxygenated blood passes from the left umbilical vein to the right atrium via the *ductus venosus*. From the right atrium the blood is then shunted through the foramen ovale to the left atrium.
- *Ductus arteriosus:* the remaining oxygenated blood passes from the right atrium to the right ventricle and enters the pulmonary trunk. From here it passes via the ductus arteriosus directly to the aorta, bypassing the lungs.

Circulation changes at birth

As the newborn takes its first breath, the pulmonary vascular resistance drops and conversion from the foetal to adult circulation starts. The following changes occur:

- The *foramen ovale* closes by the mechanical effect of the reversal in pressure between the two atria, and forms the *fossa ovalis* in adult life.
- Changes in oxygen concentration of the blood and hormonal changes contribute to the closure of the *ductus arteriosus*.

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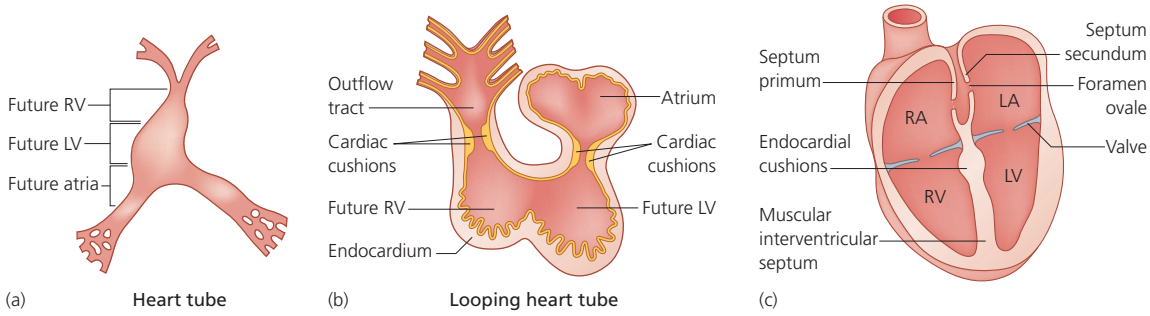

Figure A Development of the heart. LA, left atrium; LV, left ventricle; RA, right atrium; RV, right ventricle.

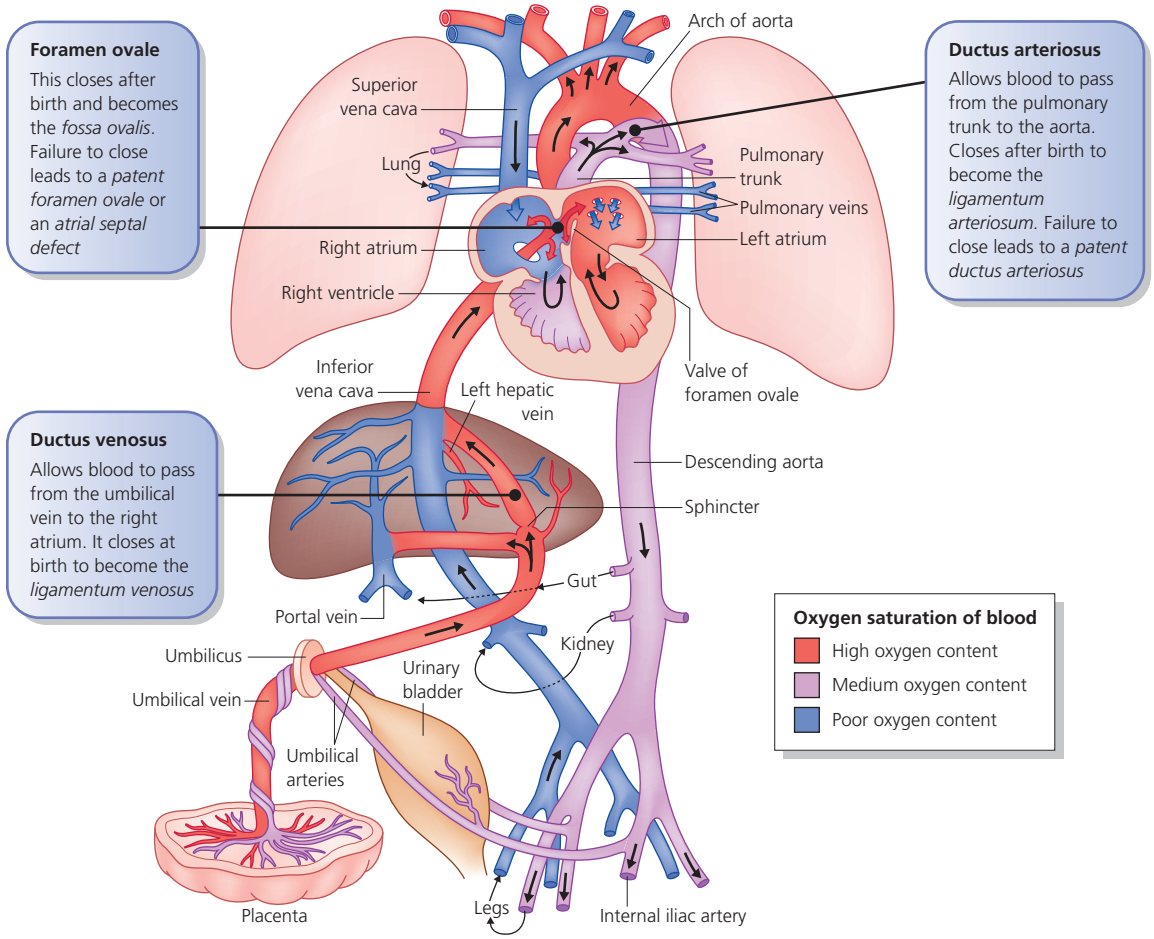

Figure B Foetal circulation and shunts.

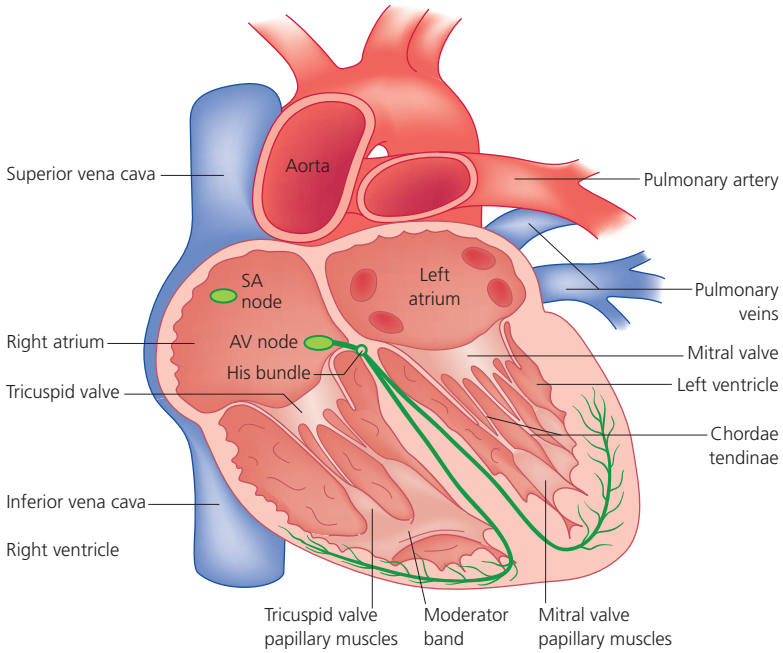

Figure C Adult heart. AV, atrioventricular; SA, sinoatrial.

The adult heart

Right atrium

This chamber is a low-pressure (0–7 mmHg), thin-walled receiving chamber for systemic and cardiac venous blood. It also contains the 'pacemaker' (SA node) and the AV node of the heart.

Right ventricle

This chamber receives the venous blood from the right atrium and ejects it into the pulmonary artery. Unlike the left ventricle, it is heavily trabeculated. It contains the moderator band, which contains part of the conduction system, and the papillary muscles of the tricuspid valve. The pressure in this chamber is 15–30 mmHg during systole.

Left atrium

This chamber receives oxygenated blood from the pulmonary veins. Clinically important structures are:

- *Pulmonary veins:* in normal hearts four pulmonary veins (two upper and two lower) drain oxygenated blood from the lungs into the left atrium.
- *Left atrial appendage:* a blind-ending sac related to the left atrium and a common site for thrombus formation in patients with atrial fibrillation.

The pressure in this chamber is slightly higher than in the right atrium (4–12 mmHg).

Left ventricle

This is a high-pressure (90–140 mmHg), thick-walled chamber, which reflects its greater contractile performance. It delivers oxygenated blood systemically. It contains the *mitral valve papillary muscles*. These are conical muscular projections from the walls of the left ventricle that attach to the chordae tendinae to support the two cusps of the mitral valve.

Vascular anatomy (Figure D)

Great vessels

- *Superior and inferior vena cava*: drain systemic deoxygenated venous blood into the right atrium.
- *Pulmonary artery:* carries *deoxygenated* blood to the lungs from the right ventricle. It has thinner walls than systemic arteries and subdivides many times into branches that carry blood to the network of 280 billion capillaries where it is oxygenated.

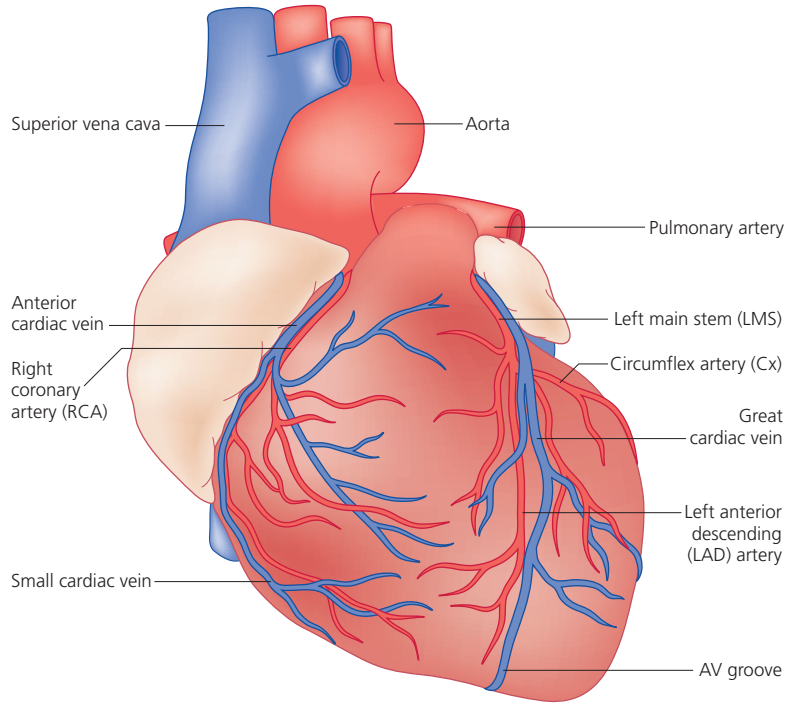

Figure D Vascular anatomy.

Box A Clinical reasons to know cardiac embryology

- A *patent foramen ovale (PFO)* is found in up to 20% of the population. The majority of people with a PFO have no symptoms. In some patients emboli form in the venous circulation and pass via the patent foramen into the systemic circulation, causing a stroke. (This is known as paradoxical embolus.) In such patients and some other selected groups, closure of the PFO is recommended. This can be done percutaneously.
- Failure of the *ductus arteriosus* to close after birth leads to the congenital heart defect *patent ductus arteriosus (PDA).* Surgical or percutaneous duct closure is recommended.
- Failure of the *interventricular septum* to fuse with the endocardial cushions gives rise to a *ventricular septal defect,* one of the most common congenital abnormalities.
- Failure of the atrial septum primum and septum secundum to fuse gives rise to the congenital defect known as *atrial septal defect.*

- *Pulmonary veins:* there are four draining oxygenated blood from the lungs into the left atrium.
- *Aorta:* carries oxygenated blood from the left ventricle to supply the rest of the body.

Arteries

Three main coronary arteries supply blood to the myocardium and arise from the sinuses of Valsalva above the semi-lunar cusps of the aortic valve. These are the RCA, the LAD and the Cx artery. The latter two arteries arise from the LMS.

- The RCA:
  - Arises from above the anterior cusp of the aortic valve.
  - Runs down the AV groove.
  - Supplies the *SA node,* the *AV node* and *right ventricle.*
  - Is 'dominant' in 85–90% of the population. It is called a 'right dominant system' when it gives rise to the *posterior descending artery* to supply the *inferior wall of the left ventricle* and *the inferior third of the interventricular septum.*