

OXFORD TEXTBOOKS IN ANAESTHESIA

Oxford Textbook of  
**Obstetric  
Anaesthesia**

Edited by

**Vicki Clark**

**Marc Van de Velde**

**Roshan Fernando**



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Oxford Textbook of

# Obstetric Anaesthesia

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**Oxford Textbook of Obstetric Anaesthesia**

Edited by Vicki Clark, Marc Van de Velde, and Roshan Fernando

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# Oxford Textbook of Obstetric Anaesthesia

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# Dedications

**Vicki Clark**

To Richard and my parents, colleagues, and patients, all of whom in their different ways, helped to make this textbook possible. Their contributions, known and unknown, small or large, have all been invaluable and my thanks go to them.

**Roshan Fernando**

To all my family who have supported me throughout my career and especially to my wife Anelia and our little girl Nia for making it special.

**Marc Van de Velde**

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To Juliette, Ella, Bas, Michiel, and Sofie for bringing joy, laughter and warmth into my life. I couldn't dream of better kids.



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# Preface

Providing obstetric anaesthesia in the delivery suite and maternity theatre presents a challenge to every practising anaesthetist. Not only are there two patients to consider, often with opposing needs, but the physiology and anatomy of the pregnant woman varies significantly from her non-pregnant counterpart. Furthermore, many procedures are done as emergencies with additional risk factors. And in recent years, the complexity of care of the pregnant population has been increased by factors such as rising maternal age and co-morbidities which in the past may have precluded pregnancy. There is therefore a need for a comprehensive,

up-to-date textbook covering all aspects of care for parturients including recent approaches to neuraxial anaesthesia, new technologies, drugs, protocols, and guidelines.

This textbook brings together international contributors who are experts in their fields and who have provided in-depth, evidence-based chapters on obstetric anaesthesia with practical information and guidance that we hope will be of value for those working in the maternity environment wherever they happen to practise.





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# Contents

Abbreviations *xiii*

Contributors *xvii*

## PART 1

### History of obstetric anaesthesia

- 1** **Historic timeline of obstetric anaesthesia** 3  
Alistair G. McKenzie

## PART 2

### Maternal and fetal physiology

- 2** **Physiological changes associated with pregnancy** 31  
Roulhac D. Toledano
- 3** **Placenta and uteroplacental perfusion** 49  
Marie-Pierre Bonnet and Anne Alice Chantry
- 4** **Fetal and neonatal physiology** 58  
Thierry Girard and Thomas Erb
- 5** **Maternal, fetal, and neonatal pharmacokinetics** 68  
Karel Allegaert and Kristel Van Calsteren

## PART 3

### Fetal and neonatal assessment and therapy

- 6** **Antenatal and intrapartum fetal evaluation** 81  
Yves Jacquemyn and Anneke Kwee
- 7** **Fetal medicine, fetal anaesthesia, and fetal surgery** 102  
Francesca Russo, Tim Van Mieghem, and Jan Deprest
- 8** **Neonatal assessment and therapy** 117  
Ewen D. Johnston and Julie-Clare Becher

## PART 4

### Fertility treatment, anaesthesia for non-obstetric surgery, and drugs in pregnancy and lactation

- 9** **Fertility treatment in the modern age: possibilities and anaesthesia** 149  
Diane De Neubourg and Sarah Devroe
- 10** **Anaesthesia for non-obstetric surgery** 157  
Vegard Dahl and Ulrich J. Spreng
- 11** **Drugs in pregnancy and lactation** 166  
Oliver Kraemer and Timothée Fraisse

## PART 5

### Obstetric management of labour and labour analgesia

- 12** **Obstetric management of labour, delivery, and vaginal birth after caesarean delivery** 179  
Roland Devlieger and Maria-Elisabeth Smet
- 13** **Non-pharmacological methods of pain relief and systemic analgesia in labour** 201  
Grace McClune and David Hill
- 14** **Initiation of neuraxial labour analgesia** 227  
Eva Roofthoof, Sarah Devroe, and Marc Van de Velde
- 15** **Maintenance of neuraxial labour analgesia** 244  
Alex Tiong Heng Sia, Ban Leong Sng, and Serene Leo
- 16** **Labour analgesia: choice of local anaesthetics** 253  
Giorgio Capogna
- 17** **Adjuvant drugs in neuraxial anaesthesia** 260  
Catherine Cromey and Susan Catling
- 18** **Alternative neural blocks for labour analgesia** 278  
Outi Palomäki and Petri Volmanen

**19 Prevention and management of breakthrough pain during neuraxial labour analgesia 287**

Jessica Bauerle and Mieke A. Soens

**PART 6**

**Anaesthesia for caesarean delivery**

**20 Neuraxial anaesthesia for caesarean delivery 297**

Sarah L. Armstrong, Michelle Walters, Katherine Cheesman, and Geraldine O'Sullivan†

**21 Intraoperative management of inadequate neuraxial anaesthesia 323**

Tauqeer Husain and Roshan Fernando

**22 General anaesthesia for caesarean delivery 337**

David M. Levy and Ieva Saule

**23 The aetiology and management of hypotension during spinal anaesthesia for caesarean delivery 350**

Robert A. Dyer, Michelle J. Arcache, and Eldrid Langesaeter

**24 Postoperative analgesia after caesarean delivery 365**

Sarah L. Armstrong and Gary M. Stocks

**25 Persistent pain after caesarean delivery and vaginal birth 380**

Patricia Lavand'homme and Fabienne Roelants

**PART 7**

**Anaesthetic complications**

**26 Management of the difficult airway 393**

Mary C. Mushambi and Rajesh Pandey

**27 Postdural puncture headache 419**

Michael J. Paech and Patchareya Nivatpumin

**28 Neurological complications of neuraxial blockade 434**

Vibeke Moen

**29 Medicolegal issues 454**

Elizabeth Combeer, Rehana Iqbal, and Steve Yentis

**PART 8**

**Obstetric complications**

**30 High dependency and intensive care 471**

Philip Barclay and Helen Scholefield

**31 Maternal mortality and morbidity 494**

Suni Halder and Steve Yentis

**32 Problems in early pregnancy 514**

W. Colin Duncan

**33 Prematurity, multiple gestation, and abnormal presentation 523**

Oonagh Keag and E. Sarah Cooper

**34 Sepsis in obstetrics 534**

Nuala Lucas, Colleen D. Acosta, and Marian Knight

**35 Obstetric haemorrhage 551**

Jane E. Norman and Vicki Clark

**36 Hypertension in pregnancy 567**

John A. Anderson, Pierre-Antoine Laloë, and Derek J. Tuffnell

**37 Thromboembolic disorders in pregnancy 587**

Salma Ballal and Ian A. Greer

**38 Amniotic fluid embolism (anaphylactoid syndrome of pregnancy) 597**

John A. Anderson, Pierre-Antoine Laloë, and Derek J. Tuffnell

**PART 9**

**Systemic disease in pregnancy**

**39 The obese parturient 607**

Fiona C. Denison and Alistair Milne

**40 Moderate to complex congenital heart disease 621**

Daryl P. Dob, Elspeth E. Pickering, and Michael A. Gatzoulis

**41 Acquired heart disease 637**

Linzi Peacock and Rachel Hignett

**42 Respiratory disease 659**

Wendy H. L. Teoh

**43 Liver disorders 676**

Chris Verslype, David Cassiman, and Johan Verhaeghe

**44 Kidney disease 687**

Kate Wiles, Kate Bramham, and Catherine Nelson-Piercy

**45 Neurological disease 703**

James Griffiths and Kate Drummond

**46 Musculoskeletal disorders 724**

James P. R. Brown and M. Joanne Douglas

**47 Endocrine and autoimmune disorders 748**

Mirjana Kendrisic and Borislava Pujic

**48 Obstetric haematology 770**

Sapna Ladani, Beverley J. Hunt, and Sue Pavord

**49 Peripartum psychiatric disorders** 795

Roch Cantwell

**50 Chronic maternal infections** 803

Kristel Van Calsteren

**51 Substance abuse** 815

Ross Junkin and Elizabeth M. McGrady

**PART 10****Recent advances in  
obstetric anaesthesia****52 Genetics** 841

Ruth Landau and Clemens Ortner

**53 Simulation** 852Mark Wigginton, Miguel Garcia,  
Timothy J. Draycott, and Neil A. Muchatuta**54 Ultrasound** 868

Sudhir Immani and John Loughrey

**55 International outreach** 880

Gordon Yuill and Simon Millar

**Appendix 1: Guidelines** 897Wint Mon, York-Mui Liu, Ioanna Mavridou,  
and Roshan Fernando**Appendix 2: Scores and scales** 947Wint Mon, York-Mui Liu, Ioanna Mavridou,  
and Roshan Fernando**Index** 961



# Abbreviations

5-HT	5-hydroxytryptamine (serotonin)	CDC	Centers for Disease Control and Prevention
AAGBI	Association of Anaesthetists of Great Britain and Ireland	CEI	continuous epidural infusion
AAP	American Association of Pediatrics	CEMACH	Confidential Enquiry into Maternal and Child Health
ACOG	American College of Obstetricians and Gynecologists	CEMD	Confidential Enquiry into Maternal Deaths
ACTH	adrenocorticotrophic hormone	CF	cystic fibrosis
AD	autosomal dominant	CGRP	calcitonin gene-related peptide
ADE	absorption, distribution, metabolism, and elimination	CHD	congenital heart disease
AED	antiepileptic drug	CI	confidence interval
AFE	amniotic fluid embolism	CIPCEA	computer-integrated patient-controlled epidural analgesia
AFLP	acute fatty liver of pregnancy	CK	creatinine kinase
AHD	acquired heart disease	CKD	chronic kidney disease
AIH	autoimmune hepatitis	CMACE	Centre for Maternal and Child Enquiries
AKI	acute kidney injury	CMV	cytomegalovirus
ALP	alkaline phosphatase	CNB	central neuraxial blockade
ALT	alanine transaminase	CNS	central nervous system
ANA	antinuclear antibody	CO	cardiac output
AP	alkaline phosphatase	CO <sub>2</sub>	carbon dioxide
APACHE	Acute Physiology and Chronic Health Evaluation	COX	cyclooxygenase
APH	antepartum haemorrhage	CPAP	continuous positive airway pressure
APS	antiphospholipid syndrome	CPR	cardiopulmonary resuscitation
aPTT	activated partial thromboplastin time	CRH	corticotropin-releasing hormone
AR	autosomal recessive	CS	Cushing's syndrome
ARDS	acute respiratory distress syndrome	CSA	Continuous Spinal Anaesthesia
AROM	artificial rupture of the membranes	CSE	combined spinal–epidural
ART	assisted reproductive technology	CSF	cerebrospinal fluid
ASA	American Society of Anesthesiologists	CSH	cranial subdural haematoma
ASD	atrial septal defect	CTG	cardiotocography
ASM	airway smooth muscle	CTPA	computed tomography pulmonary angiography
AST	aspartate transaminase	CVA	cerebrovascular accident
ATP	Adenosine triphosphate	CVC	central venous catheter
AUROC	area under the receiver operating characteristic curve	CVS	cardiovascular system
AV	atrioventricular	CXR	chest X-ray
AVM	arteriovenous malformation	CYP	cytochrome p450
BMI	body mass index	DAS	Difficult Airway Society
bpm	beats per minute	DCM	dilated cardiomyopathy
BPP	biophysical profile score	DDI	decision to delivery interval
cAMP	cyclic adenosine monophosphate	DHPR	dihydropyridine
CBG	corticosteroid-binding globulin	DIC	disseminated intravascular coagulation
CD	Caesarean Delivery	DKA	diabetic ketoacidosis
		DM	diabetes mellitus
		DMARD	Disease modifying anti-rheumatic drugs

DPG	diphosphoglycerate	ICD-10	International Classification of Diseases, tenth revision
DVT	deep vein thrombosis	ICNARC	Intensive Care National Audit and Research Centre
EA	epidural anaesthesia	ICP	intracranial pressure
EC <sub>50</sub>	median effective concentration	ICS	inhaled corticosteroid
ECC	excitation-contraction coupling	ICSI	intracytoplasmic sperm injection
ECG	electrocardiogram	ICU	intensive care unit
ED	Ehlers-Danlos	IE	infective endocarditis
ED <sub>50</sub>	effective dose in 50% of subjects	IHD	ischaemic heart disease
ED <sub>95</sub>	effective dose in 95% of subjects	IIH	Idiopathic intracranial hypertension
EFM	electronic fetal monitoring	ILCOR	International Liaison Committee on Resuscitation
EP	ectopic pregnancy	IM	intramuscular
EPAU	early pregnancy assessment unit	INR	international normalized ratio
EREM	extended-release epidural morphine	IR	interventional radiology
ERPHD	European Registry on Pregnancy and Heart Disease	ITP	idiopathic thrombocytopenic purpura
ESBL	extended-spectrum beta-lactamase	ITU	intensive therapy unit
ESC	European Society of Cardiology	IUGR	intrauterine growth restriction
ESRD	end-stage renal disease	IV	intravenous
ETT	endotracheal tube	IVC	inferior vena cava
EUA	examination under anaesthetic	IVF	in vitro fertilization
FAS	fetal alcohol syndrome	LA	local anaesthetic
FBC	full blood count	LABA	long-acting beta-2-agonist
FBS	fetal blood sampling	LAST	local anaesthetic systemic toxicity
FDA	Food and Drug Administration	LBP	low back pain
FER	frozen embryo replacement	LDH	lactate dehydrogenase
FET	frozen embryo transfer	LFT	liver function test
FEV <sub>1</sub>	forced expiratory volume in 1 second	LH	luteinizing hormone
FFN	fetal fibronectin	LMA	laryngeal mask airway
FHR	fetal heart rate	LMN	Lower Motor Neuron
FIGO	Federation Internationale des Gynécologues et des Obstétriciens	LMWH	low-molecular-weight heparin
FLF	fetal lung fluid	LOR	loss of resistance
FPG	fasting plasma glucose	LOS	lower oesophageal sphincter
FRC	functional residual capacity	LRTA	leukotriene-receptor antagonist
FSH	follicle-stimulating hormone	LSB	lumbar sympathetic block
FVC	forced vital capacity	LUD	left uterine displacement
GA	general anaesthesia	MAC	minimum alveolar concentration
GABA	gamma-aminobutyric acid	MAHA	microangiopathic haemolytic anaemia
GBS	Guillain-Barré syndrome	MBRRACE-UK	Mothers and Babies: Reducing Risk through Audits and Confidential Enquiries across the United Kingdom
GDM	gestational diabetes mellitus	MCA	middle cerebral artery
GFR	glomerular filtration rate	MCV	mean cell volume
GGT	gamma-glutamyl transferase	MDE	Maternal Death Enquiry
GH	gestational hypertension or growth hormone	MELD	Model of End Stage Liver Disease
GI	gastrointestinal	MEWS	Modified Early Warning Score
GMC	General Medical Council	MFS	Marfan syndrome
GnRH	gonadotropin-releasing hormone	MG	myasthenia gravis
GOR	gastro-oesophageal reflux	MH	malignant hyperthermia
GP	general practitioner	MHRA	Medicines & Healthcare products Regulatory Agency
hCG	human chorionic gonadotropin	MHS	malignant hyperthermia-susceptible
HCM	hypertrophic cardiomyopathy	MI	myocardial infarction
HDU	high dependency unit	MLAC	minimum local analgesic concentration
HELLP	haemolysis, elevated liver enzyme levels, and low platelet count	MLAD	minimum local analgesic dose
HIT	heparin-induced thrombocytopenia	MMR	maternal mortality ratio
HLHS	hypoplastic left heart syndrome	MPM	Mortality Probability Model
HPA	hypothalamic-pituitary-adrenal	MRI	Magnetic Resonance Imaging
HR	heart rate		
HSV	herpes simplex virus		
HUS	haemolytic uraemic syndrome		

MRSA	meticillin-resistant <i>Staphylococcus aureus</i>	RSI	rapid sequence induction
NA	neuraxial anaesthesia	RYR1	ryanodine
NAFLD	non-alcoholic fatty liver disease	SA	spinal anaesthesia
NAP	National Audit Project	SABA	short-acting beta-2-agonist
NICE	National Institute of Health and Care Excellence	SAD	supraglottic airway device
NMB	neuromuscular blockade	SaO <sub>2</sub>	arterial oxygen saturation
NMDA	N-methyl-D-aspartate	SAPS	Simplified Acute Physiology Score
NO	nitric oxide	SCASMM	Scottish Confidential Audit of Severe Maternal Morbidity
NSAID	non-steroidal anti-inflammatory drug	SCI	spinal cord injury
NT	nuchal translucency	SGA	small for gestational age
NYHA	New York Heart Association	SH	spinal haematoma
O <sub>2</sub>	oxygen	SIGN	Scottish Intercollegiate Guidelines Network
OAA	Obstetric Anaesthetists' Association	SLE	systemic lupus erythematosus
ODP	operating department practitioner	SNP	single nucleotide polymorphism
OGTT	oral glucose tolerance test	SSRI	selective serotonin reuptake inhibitor
OHSS	ovarian hyperstimulation syndrome	SSS	single-shot spinal
OR	odds ratio/Operating Room	SV	stroke volume
PAC	pulmonary artery catheter	SVR	systemic vascular resistance
PaCO <sub>2</sub>	arterial partial pressure of carbon dioxide	SVT	supraventricular tachycardia
PAI	plasminogen activator inhibitor	T1D	type 1 diabetes
PAPP-A	pregnancy-associated plasma protein-A	T2D	type 2 diabetes
PB	puddendal block	T <sub>3</sub>	triiodothyronine
PCA	patient-controlled analgesia	T <sub>4</sub>	thyroxine
PCB	paracervical block	TAP	transversus abdominis plane
PCEA	patient-controlled epidural analgesia	TB	tuberculosis
PCO <sub>2</sub>	partial pressure of carbon dioxide	TBG	thyroxine-binding globulin
PCR	polymerase chain reaction	TCPC	total cavopulmonary connection
PD	pharmacodynamics	TENS	transcutaneous electrical nerve stimulator
PDPH	postdural puncture headache	TM	transverse median
PDPM	postdural puncture meningitis	TSH	thyroid-stimulating hormone
PEEP	positive end-expiratory pressure	TT	thrombin time
PEF	peak expiratory flow	TTP	thrombotic thrombocytopenic purpura
PEFR	peak expiratory flow rate	TTTS	twin-to-twin transfusion syndrome
PG	prostaglandin	TV	tidal volume
PIP	positive inspiratory pressure	UDCA	ursodeoxycholic acid
PK	pharmacokinetics	UFH	unfractionated heparin
PND	paroxysmal nocturnal dyspnoea	UKHCDO	United Kingdom Haemophilia Centre Doctors' Organisation
PPCM	peripartum cardiomyopathy	UKOSS	UK Obstetric Surveillance System
PPH	postpartum haemorrhage	ULN	upper limit of normal
PPROM	preterm premature rupture of membranes	UMN	Upper Motor Neuron
PPSP	persistent postsurgical pain	V/Q	ventilation/perfusion
PRB	pregnancy-related backache	VAPS	visual analogue pain scale
PROM	premature rupture of membranes	VAS	visual analogue scale
PSO	paramedian sagittal oblique	VBAC	vaginal birth after caesarean
PT	prothrombin time	VD	vaginal delivery
PTE	pulmonary thromboembolism	VRS	verbal rating score
PVB	paravertebral block	VSD	ventricular septal defect
RA	rheumatoid arthritis	VT	ventricular tachycardia
RBC	red blood cell	VTE	venous thromboembolism
RBF	renal blood flow	vWD	von Willebrand disease
RCOG	Royal College of Obstetricians and Gynaecologists	vWF	von Willebrand factor
RCT	randomized controlled trial	WFSA	World Federation of Societies of Anaesthesiologists
REM	rapid eye movement	WHO	World Health Organization
RHD	rheumatic heart disease		
RR	relative risk		





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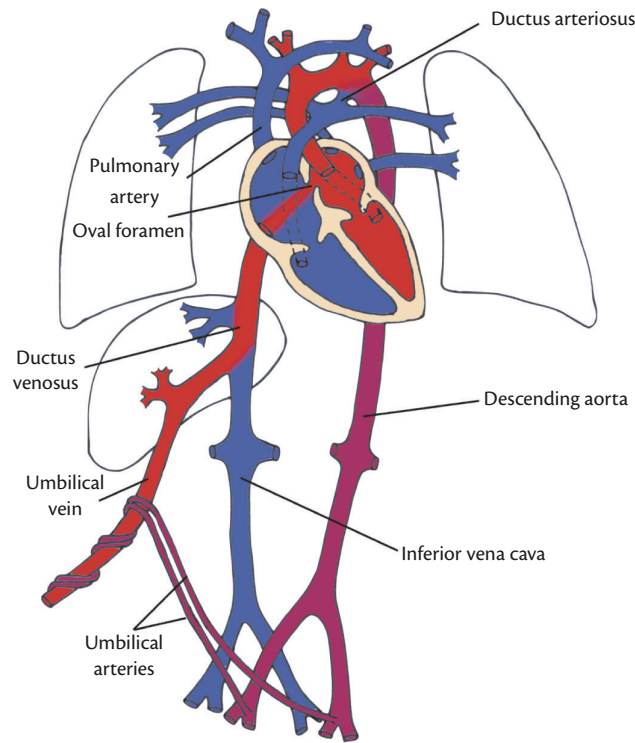
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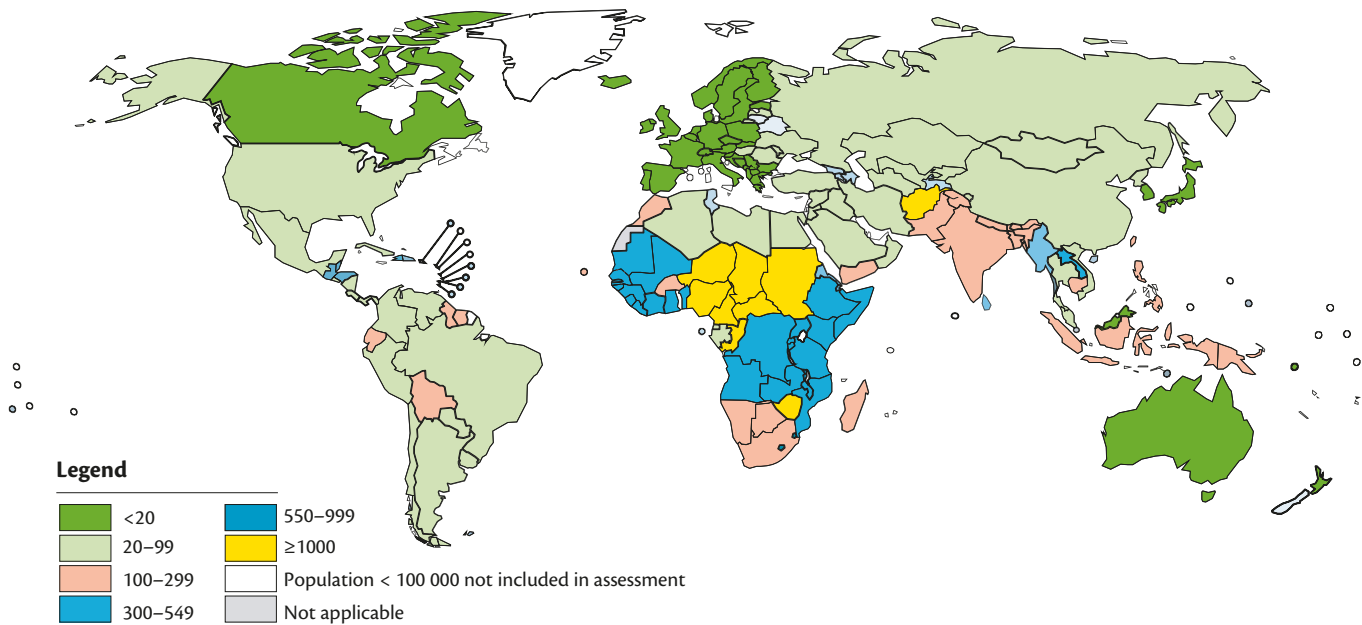
**Figure 4.1** The fetal circulation before birth. Fetal circulation is characterized by three shunts: (1) ductus venosus, (2) oval foramen, and (3) ductus arteriosus. Blood flow is directed to bypass the liver in the ductus venosus. From the right atrium oxygenated blood flows through the oval foramen into the left atrium, left ventricle, and into the aorta.

PHYSIOLOGICAL PARAMETERS	3	2	1	0	1	2	3
Respiration Rate	≤8		9–11	12–20		21–24	≥25
Oxygen Saturations	≤91	92–93	94–95	≥96			
Any Supplemental Oxygen		Yes		No			
Temperature	≤35.0		35.1–36.0	36.1–38.0	38.1–39.0	≥39.1	
Systolic BP	≤90	91–100	101–110	111–219			≥220
Heart Rate	≤40		41–50	51–90	91–110	111–130	≥131
Level of Consciousness				A			V, P, or U

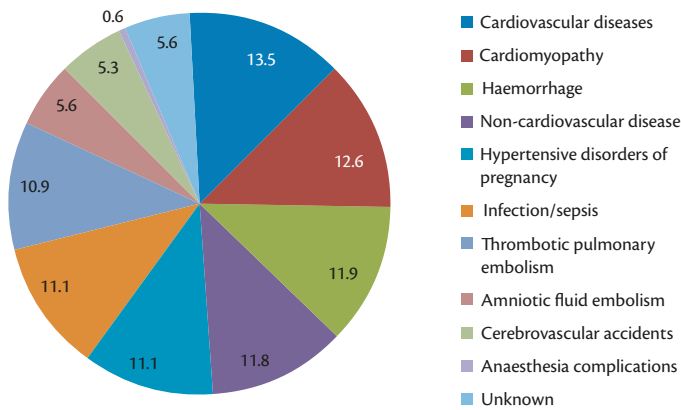
**Figure 30.2** The National Early Warning Score (NEWS). Reproduced with permission from the Royal College of Physicians. *National Early Warning Score (NEWS): Standardising the assessment of acute illness severity in the NHS*. Report of a working party. © Royal College of Physicians 2012.

NEWS scores	Clinical risk
0	Low
Aggregate 1–4	
RED score (Individual parameter scoring 3)	Medium
Aggregate 5–6	
Aggregate 7 or more	High

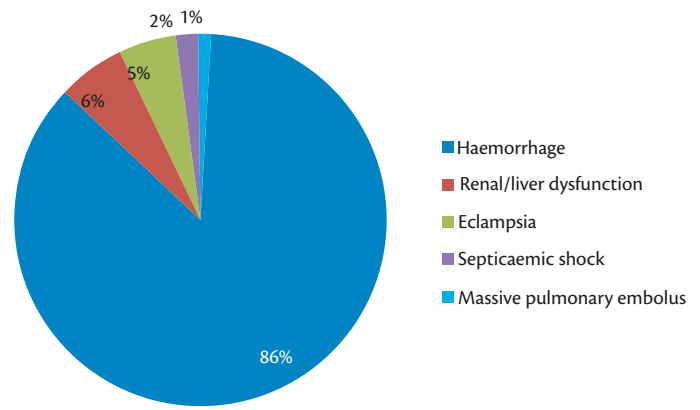
**Figure 30.3** The National Early Warning Score (NEWS) thresholds and triggers. Reproduced with permission from the Royal College of Physicians. *National Early Warning Score (NEWS): Standardising the assessment of acute illness severity in the NHS*. Report of a working party. © Royal College of Physicians 2012.



**Figure 31.1** Maternal mortality ratio (per 100,000 live births) worldwide, 2010. Reproduced with permission from WHO, *Trends in Maternal Mortality: 1990 to 2010* WHO, UNICEF, UNFPA and The World Bank estimates, Geneva, World Health organization, Copyright © 2012.

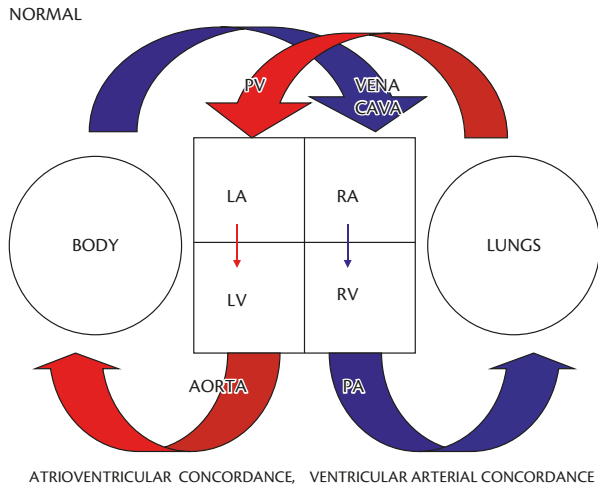


**Figure 31.10** Causes of pregnancy-related deaths in the United States: 2006 to 2007. Data from Berg CJ. From identification and review to action--maternal mortality review in the United States. *Semin Perinatol* 2012; 36:7-13, Copyright © 2012 Elsevier.

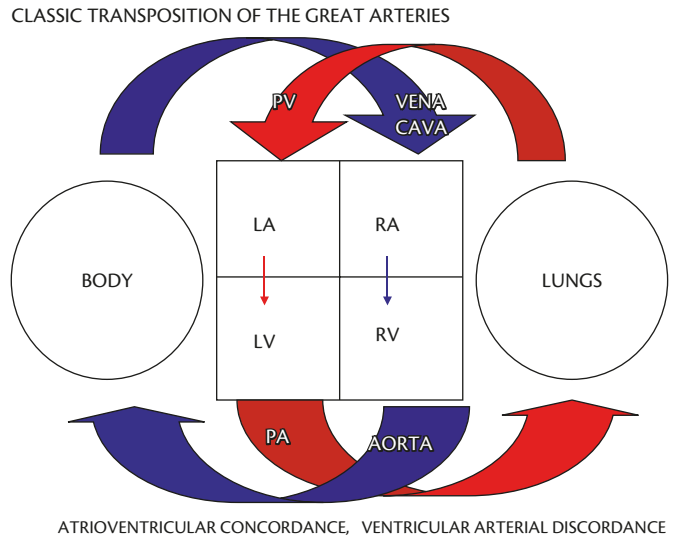


**Figure 31.11** Causes of maternal morbidity (as a percentage of total) from Scottish Confidential Audit of Severe Maternal Morbidity: 2006-2008. Data from various sources (see References).

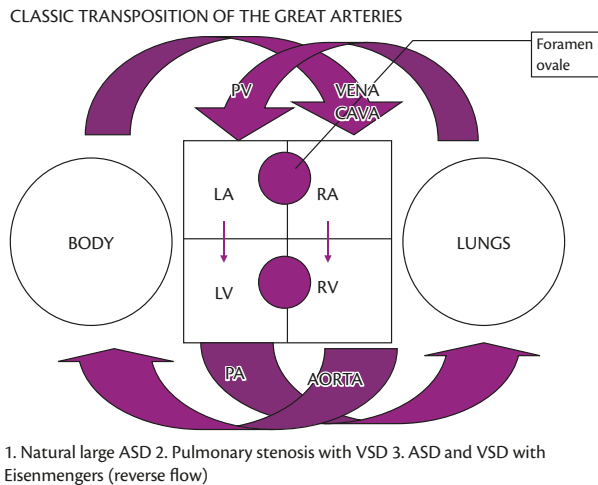




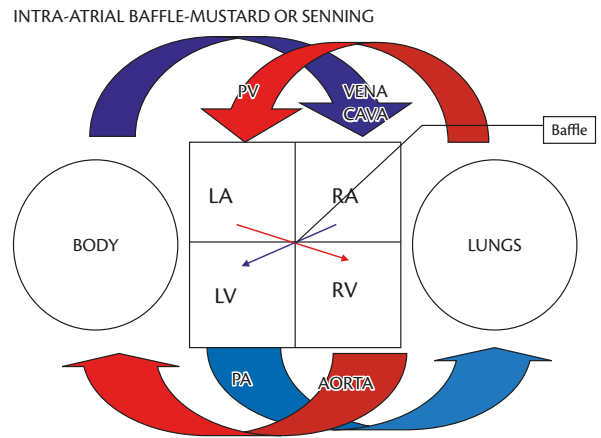
**Figure 40.1** The normal configuration.  
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**Figure 40.2** Classic transposition of the great arteries.  
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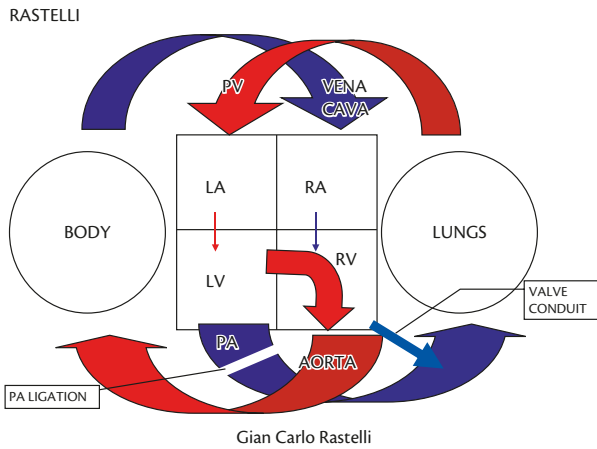


**Figure 40.3** Classic transposition of the great arteries with a large shunt.  
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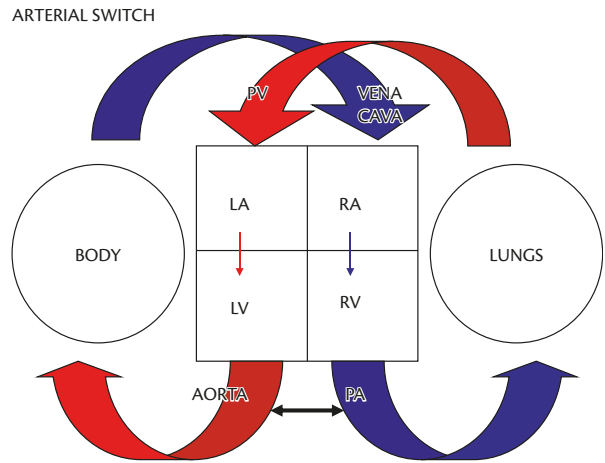


**Figure 40.4** Intra-atrial baffle (Mustard or Senning atrial switch), represented by the red and blue crossed arrows.  
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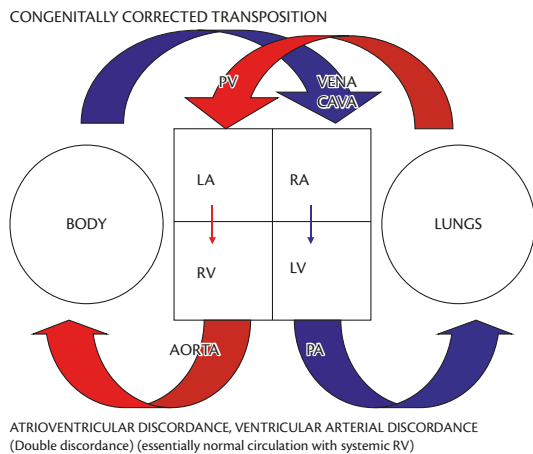




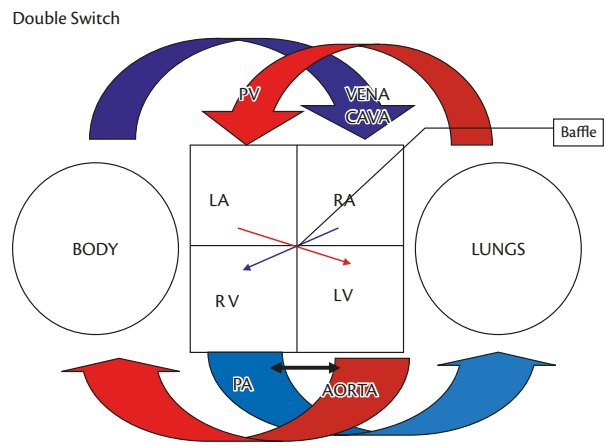
**Figure 40.5** Rastelli procedure. The large red arrow represents the Dacron tunnel from the left ventricle to the aorta. The blue arrow represents the valved conduit from the right ventricle to the pulmonary artery. The pulmonary trunk is transected and sewn up. Reprinted from *International Journal of Obstetric Anesthesia*, Volume 19, edition 3, D.P. Dob, M.A. Naguib, M.A. Gatzoulis, A functional understanding of moderate to complex congenital heart disease and the impact of pregnancy. Part I: The transposition complexes, pp. 298–305, Copyright (2010), with permission from Elsevier.



**Figure 40.6** Arterial switch (Jatene) procedure. Aorta and pulmonary artery switched to the correct ventricle (represented by the black arrow). The coronary arteries are transected with a 'button' of pulmonary artery wall and re-implanted into the neo-aorta, which was the old pulmonary artery. Reprinted from *International Journal of Obstetric Anesthesia*, Volume 19, edition 3, D.P. Dob, M.A. Naguib, M.A. Gatzoulis, A functional understanding of moderate to complex congenital heart disease and the impact of pregnancy. Part I: The transposition complexes, pp. 298–305, Copyright (2010), with permission from Elsevier.



**Figure 40.7** Congenitally corrected transposition of the great arteries showing double discordance. Reprinted from *International Journal of Obstetric Anesthesia*, Volume 19, edition 3, D.P. Dob, M.A. Naguib, M.A. Gatzoulis, A functional understanding of moderate to complex congenital heart disease and the impact of pregnancy. Part I: The transposition complexes, pp. 298–305, Copyright (2010), with permission from Elsevier.



**Figure 40.8** Double-switch procedure—an intra-atrial switch is combined with an arterial switch to give a near normal circulation to repair congenitally corrected transposition of the great arteries. Reprinted from *International Journal of Obstetric Anesthesia*, Volume 19, edition 3, D.P. Dob, M.A. Naguib, M.A. Gatzoulis, A functional understanding of moderate to complex congenital heart disease and the impact of pregnancy. Part I: The transposition complexes, pp. 298–305, Copyright (2010), with permission from Elsevier.