Fundamentals of Anaesthesia

Fourth Edition

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To our families, whose support has helped us overcome the challenges of creating this textbook

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Preface to the first edition

The advent of a syllabus for the FRCA examination, itself a requirement of the STA, seemed to me to provide an ideal opportunity for a dedicated revision textbook. It will therefore be of no surprise to readers that this volume mirrors closely the syllabus for the primary FRCA in both structure and content.

Having enlisted the willing help of my two co-editors, Tim Smith and Ted Lin, we set about recruiting authors to contribute. Chapter authors have been chosen for their ability and known prowess as teachers and a deliberate policy of not inviting 'usual' contributions from frequently seen names was taken. Having said that, several primary examiners appear as contributors and within each chapter coverage of revision topics has been kept as appropriate to the examination as possible.

To reduce the variability that is the bane of multi-author texts I have personally edited every chapter to ensure consistency of style and it is a reflection of the workload involved that it has taken three years to complete this project. I am grateful to all contributing authors for their tolerance and good humour during alteration of their golden prose.

Whilst no single book can cover the entire syllabus as a 'one stop' aid, the majority of material covered in the examination is detailed within these pages. Some items lately included in the syllabus, after completion of the manuscript, will be added in future editions (such as the anatomy pertaining to ankle block). Candidates will, however, be well served if this book is used as a general basis for revision.

I am extremely grateful to Rob Jones, who has been responsible for generating virtually all the artwork within this text, the few other diagrams being credited to their sources.

Thanks are also due to both my co-editors for their extensive work and dedication. If this volume enables any candidate to pass the primary examination, who would not have done so otherwise, then our job will have been well done.

Colin Pinnock

Preface to the second edition

I am delighted that the success of *Fundamentals* has enabled us to proceed to an early second edition. It will be apparent to the familiar reader that this edition has undergone rather more than a simple facelift. A great deal of feedback from both examiners and candidates has been used to modify and shape this current volume. New authors have been brought in to Section 1 to revise and modify the clinical chapters where necessary (incorporating several important and new areas of emerging knowledge), whilst resuscitation and trauma chapters have been updated by their original writers. Anatomy has been extended in scope to reflect subjects that are currently popular in the Primary FRCA.

In Section 2, there are new chapters on neurology and endocrinology, and an extra chapter on neonatal physiology has been incorporated to satisfy the demands of the examination syllabus.

Section 3 has been updated comprehensively with the removal of some drugs now lapsed and the incorporation of newer agents that have become available. By popular demand a new chapter on clinical trial design rounds off the pharmacology section.

It is, however, Section 4 that has undergone the most radical changes. I am very grateful to Ted Lin for the completely new physics and equipment chapters, which provide excellent core revision in these important areas. A greater number of diagrams (and many revised graphics) throughout the book and a completely new index complete the modifications over the first edition.

I thus believe that the second edition of *Fundamentals* is an even better revision aid to the Primary FRCA examination and will build on the reputation of its forerunner. Once again my thanks go to my three co-editors for their hard work and determination.

Colin Pinnock

Preface to the third edition

I am privileged to have led the creation of the third edition of this popular Primary FRCA text, ably helped by my three co-editors. Once again, feedback from users of the book has helped enormously in developing *FoA3*. The Royal College of Anaesthetists' publication of the Primary syllabus within the Competency-based Training Framework has led us to include that knowledge base, uniquely referenced to *Fundamentals*, in a new Appendix. A number of new contributors have enhanced the proportion of current and past examiners amongst our writers. The greater use of colour allows the reader to navigate more easily, and changes to technique boxes make that information easier to assimilate. This edition contains a number of new chapters in addition to widespread updates, and has been thoroughly copy-edited by Hugh Brazier to an unrivalled standard of consistency over the previous editions.

Whilst all chapters have been reviewed, there are a number of significant changes.

- Section 1 contains a significantly updated chapter in the growing field of preoperative assessment, and a brand new chapter on resuscitation. The inclusion of the DAS algorithms for airway management is a particular bonus.
- In Section 2 Ted Lin has written an additional chapter specifically covering the physiology of pain, and Colin Pinnock has edited haematology to bring it more in line with the current syllabus.
- Section 3 has a new chapter on analgesic drugs, taking account of the substantial developments in this area. The new chapter on mechanisms of drug action puts clear emphasis on the current thinking on the mechanism of anaesthesia.
- In Section 4, Ted Lin has put together a clear and concise statistics chapter, which will make preparation for this part of the exam straightforward. The inclusion of aspects of ultrasound and MRI scanning here and in the clinical section follows its incorporation into the syllabus.

Despite suggestions to expand *Fundamentals* to cover anaesthesia to higher levels and in greater depth, we have adhered to our original aim of providing a textbook specifically designed around the RCA Primary Fellowship. In so doing, we have been better able to adapt to changes in that exam as well as in anaesthetic core knowledge. The result is a much more effective exam preparation tool, which in turn is frequently used as a starting point for anaesthetists (and indeed others) of all grades including consultants, some of whom achieved exam success helped by the first edition. Finally, I am particularly grateful to Colin for his help and advice during my turn at leading the editorial process.

We were saddened to hear of the death of Dr Andy Ogilvy, author of Section 2, Chapter 11, as this edition was in preparation.

Tim Smith

Preface to the fourth edition

We are greatly pleased to be writing this introduction to our fourth edition of *Fundamentals of Anaesthesia*. Technology, clinical practice and the working environment for anaesthetists are continually changing and evolving, and we have attempted to reflect these trends in this new edition.

The curriculum for the FRCA exam is ever-expanding and presents a constant challenge for those in training. However, the basic principles for our specialty – of care for our patients, clinical skills and the application of scientific knowledge – remain constant, as they always have been.

We have taken care throughout to avoid unnecessary expansion of the material covered, and to relate material to the curriculum for the fellowship exam, as well as focusing on the basic principles of anaesthesia. One of our priorities has always been to try and make it easier for our readers to identify key facts and concepts in the mass of information that they are inevitably presented with – to gain a perspective on the topics contained in this volume.

So in this edition we introduce yellow and green boxes. Yellow boxes highlight facts or principles which we feel merit emphasis, while green boxes detail examples, calculations or techniques which are of interest but may be bypassed without interrupting the flow of the main text. The green boxes can be returned to if so desired and examined separately.

In this edition the clinical section (Section 1) has been revised and updated, taking account of the changing guidelines that influence clinical practice and focusing on the explanations behind them. The regional anaesthesia chapter now includes an introduction to ultrasound techniques.

In the physiology section (Section 2) all chapters have been revised and new chapters have been written for gastroenterology, neurophysiology, metabolism and temperature regulation, and renal physiology.

In the pharmacology section (Section 3), as well as introducing new drugs, the explanations have continued to reflect the changes in expectations for the evolving Primary FRCA examination.

The statistics chapter is now combined with the clinical trials chapter, bringing basic science and clinical research practice together, highlighting the need for basic statistical knowledge in order to interpret and design studies appropriately.

It is with great sadness that we mark the passing of our friend and colleague Colin Pinnock with this edition. He was the originator of this project and will always be remembered, not only as a prolific author but also as an uncompromising educator.

We, the editors, wish our readers an enjoyable and challenging read.

Ted Lin and Tim Smith

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Alma Medical
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- Figure 5.27 Oxford HELP (head elevating laryngoscopy pillow) system

American College of Cardiology/American Heart Association
Chapter 1
- Figure 1.8 Clinical predictors of increased perioperative cardiovascular risk
- Figure 1.9 Surgery-specific cardiac risk for non-cardiac surgery

Association of Anaesthetists of Great Britain and Ireland
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- Green box Management of a patient with suspected anaphylaxis

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Chapter 5
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***The Sourcebook of Medical Illustration*, ed. P. Cull. Carnforth: Parthenon Publishing Group, 1989**
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Abbreviations

2,3-DPG	2,3-diphosphoglycerate
5-HT	5-hydroxytryptamine (serotonin)
A	adenine
A&E	accident and emergency
AAGBI	Association of Anaesthetists of Great Britain and Ireland
ABC	airway, breathing, circulation
ABV	arterial blood volume
AC	alternating current
ACA	anterior cerebral artery
ACC	anterior cingulate cortex
ACE	angiotensin-converting enzyme
ACh	acetylcholine
ACT	activated clotting time
ACTH	adrenocorticotropic hormone
ACTH-RH	adrenocorticotropic hormone releasing hormone
ADCC	antibody-dependent cell-mediated cytotoxicity
ADH	antidiuretic hormone
ADP	adenosine diphosphate
ADR	adverse drug reaction
ADROIT	Adverse Drug Reactions Online Information Tracking
AED	automated external defibrillator
AER	auditory evoked response
AF	atrial fibrillation
AFE	amniotic fluid embolism
AFOI	awake fibreoptic intubation
AH	absolute humidity
AIDS	acquired immune deficiency syndrome
ALS	advanced life support
AMD	airway management device
AMP	adenosine monophosphate
AMPA	α-amino 3-hydroxy 5-methyl 4-isoxazolepropionic acid
Ang I	angiotensin I
Ang II	angiotensin II
ANOVA	analysis of variance
ANP	atrial natriuretic peptide
ANS	autonomic nervous system
ANSI	American National Standards Institute
AP	action potential
AP	anaesthetic proof
AP	anteroposterior
APC	activated protein C
APC	antigen-presenting cell
APCR	activated protein C resistance
APG	anaesthetic proof category G
APL	adjustable pressure-limiting
APTT	activated partial thromboplastin time
AQP	aquaporin
ARDS	acute respiratory distress syndrome
ARR	absolute risk reduction
ASA	American Society of Anesthesiologists
ASIC	acid-sensing ion channel
ASIS	anterior superior iliac spine
AT	anaerobic threshold
AT	angiotensin
ATLS	advanced trauma life support
ATP	adenosine triphosphate
ATPS	ambient temperature and pressure saturated
AUC	area under curve
AV	alveolar ventilation
AV	atrioventricular
AVNRT	AV nodal re-entry tachycardia
AVRT	AV re-entry tachycardia
BAER	brainstem auditory evoked response
bd	twice a day
BDNF	brain-derived neurotrophic factor
BER	basal electrical rhythm
BIS	bispectral index
BLS	basic life support
B_M	B memory cell
BMI	body mass index

BMR	basal metabolic rate
$BMRO_2$	basal metabolic rate of oxygen consumption
BNF	British National Formulary
BNP	brain natriuretic peptide
BP	blood pressure
BP	boiling point
BPI	Brief Pain Inventory
bpm	beats per minute
BS	British Standard
BSA	body surface area
BSE	bovine spongiform encephalopathy
C	cytosine
Ca	arterial compliance
CAM	cell adhesion molecule
CAM	confusion assessment method
cAMP	cyclic adenosine monophosphate
C_AO_2	alveolar oxygen content
CaO_2	arterial oxygen content
CAPD	continuous ambulatory peritoneal dialysis
CBF	cerebral blood flow
CBG	capillary blood glucose
CBG	corticosteroid-binding globulin
CBV	cerebral blood volume
CC	closing capacity
CCK	cholecystokinin
CcO_2	capillary oxygen content
CFAM	cerebral function analysing monitor
cGMP	cyclic guanosine monophosphate
CGRP	calcitonin gene-related peptide
CHM	Commission on Human Medicines
CI	cardiac index
CI	confidence interval
CJD	Creutzfeldt–Jakob disease
CK	creatine kinase
CKD	chronic kidney disease
CL	confidence limit
Cl	clearance
C_L	lung compliance
cmH_2O	centimetres of water (pressure)
CMR	cerebral metabolic rate
$CMRO_2$	cerebral metabolic rate of oxygen consumption
CMV	cytomegalovirus
CNB	central nerve block
CNS	central nervous system
CO	cardiac output
CoA	co-enzyme A
COAD	chronic obstructive airways disease
COMT	catechol-O-methyl transferase
COP	colloid osmotic pressure
COPA	cuffed oropharyngeal airway
COPD	chronic obstructive pulmonary disease
COSHH	Control of Substances Hazardous to Health
COX	cyclo-oxygenase
CP	creatine phosphate
CPAP	continuous positive airway pressure
CPDA	citrate phosphate dextrose adenine
CPK MB	creatine phosphokinase (cardiac isoenzyme)
CPP	cerebral perfusion pressure
CPP	coronary perfusion pressure
CPR	cardiopulmonary resuscitation
CPX	cardiopulmonary exercise
C_R	respiratory system compliance
CRP	C-reactive protein
CRPS	complex regional pain syndrome
CSE	combined spinal–epidural
CSF	cerebrospinal fluid
CSF	colony-stimulating factor
CSM	Committee on Safety of Medicines
CT	computerised tomography
CTZ	chemoreceptor trigger zone
CV	controlled ventilation
CvO_2	mixed venous oxygen content
CVP	central venous pressure
CVR	cerebrovascular resistance
CVRIII	continuous variable-rate intravenous insulin infusion
CVS	cardiovascular system
Cw	chest wall compliance
CYP	cytochrome P450
D	dopaminergic
D&C	dilatation and curettage
DAG	diacylglycerol
DBS	double-burst stimulation
DC	direct current
DCR	dacryocystorhinostomy
DDAVP	1-deamino-8-arginine vasopressin
DHEA	dehydroepiandrosterone
DHFR	dihydrofolate reductase
DHPS	deoxyhypusine synthase
DIC	disseminated intravascular coagulation
DIT	di-iodotyrosine
DKA	diabetic ketoacidosis
DLCO	diffusing capacity of the lungs for carbon monoxide

DNA	deoxyribonucleic acid
DNACPR	do not attempt cardiopulmonary resuscitation
$\dot{D}O_2$	oxygen delivery
DPP-4	dipeptidylpeptidase-4
DPT	dorsolateral pontine tegmentum
DRG	dorsal root ganglion
DVT	deep venous thrombosis
Ea	arterial elastance
EAR	expired air respiration
EBC	effective blood concentration
EBP	epidural blood patch
EC	effective concentration
ECA	electrical control activity
ECF	extracellular fluid
ECG	electrocardiogram
ECMO	extracorporeal membrane oxygenation
ED_{50}	effective dose in 50% of population
ED_{95}	effective dose in 95% of population
EDP	end-diastolic point
EDPVR	end-diastolic pressure–volume relationship
EDRF	endothelium-derived relaxing factor
EDTA	ethylenediamine tetra-acetate
EDV	end-diastolic volume
EEG	electroencephalogram
Ees	end-systolic elastance
EF	ejection fraction
eGFR	estimated glomerular filtration rate
EM	electromagnetic
EMD	electromechanical dissociation
EMF	electromotive force
EMG	electromyogram
EMLA	eutectic mixture of local anaesthetic
EMS	emergency medical service
ENS	enteric nervous system
ENT	ear nose and throat
EPO	erythropoietin
EPSP	excitatory postsynaptic potential
ER	endoplasmic reticulum
ER	extraction ratio
ERK	extracellular signal-regulated kinase
ERPC	evacuation of retained products of conception
ERV	expiratory reserve volume
ESBL	extended-spectrum β-lactamase
ESKF	end-stage kidney failure
ESP	end-systolic point
ESPVR	end-systolic pressure–volume relationship
ESR	erythrocyte sedimentation rate
ESV	end-systolic volume
ET	endothelium
ETC	oesophageal–tracheal combitube
$ETCO_2$	end-tidal carbon dioxide
ETT	endotracheal tube
f	frequency of breaths
F	gas flow
F/M	feto-maternal
FA	fatty acid
F_A	alveolar tension
FAC	fractional area change
F_ACO_2	fractional alveolar carbon dioxide concentration
$FADH_2$	flavine adenine dinucleotide
FAST	focused assessment with sonography for trauma
FATE	focus assessed transthoracic echocardiography
FBC	full blood count
FDC	F-decalin
FDP	fibrin degradation product
Fe^{2+}	ferrous iron state
$F\bar{E}CO_2$	fractional mixed expired carbon dioxide concentration
FEMG	frontalis electromyogram
FEV%	ratio of FEV_1 to FVC
FEV_1	forced expiratory volume in one second
FFA	free fatty acid
FFI	fatal familial insomnia
FFP	fresh frozen plasma
FFT	fast Fourier transform
FG	fat group
FGF	fresh gas flow
FI	fusion inhibitor
F_I	inspired vapour tension
F_IO_2	fractional inspired oxygen concentration
FLAP	five-lipoxygenase-activating protein
FNHTR	febrile non-haemolytic transfusion reactions
FRC	functional residual capacity
FSH	follicle-stimulating hormone
FSH-RH	follicle-stimulating hormone releasing hormone
FTPA	F-tripropylamine
FVC	forced vital capacity
G	guanine
GABA	γ-aminobutyric acid

GCCR	guanylyl-cyclase-coupled receptor
GCS	Glasgow coma scale
GDNF	glial cell-line-derived neurotrophic factor
GDP	guanosine diphosphate
GE	gradient echo
GFR	glomerular filtration rate
GH	growth hormone
GH-IH	growth hormone inhibiting hormone
GH-RH	growth hormone releasing hormone
GI	gastrointestinal
GIFTASUP	Guidelines on Intravenous Fluid Therapy for Adult Surgical Patients
GLP-1	glucagon-like peptide 1
GLUT4	glucose transporter type 4
GLUT5	glucose transporter type 5
GlyR	glycine receptor
GMC	General Medical Council
GMP	guanosine monophosphate
Gn-RH	gonadotropin releasing hormone
GP	general practitioner
GPCR	G-protein-coupled receptor
GRK	GPCR-kinase
GSS	Gerstmann–Sträussler–Scheinker syndrome
GTN	glyceryl trinitrate
GTP	guanosine triphosphate
HAFOE	high airflow oxygen enrichment
HAS	human albumin solution
Hb	haemoglobin
HbA	adult haemoglobin
HbCO	carboxyhaemoglobin
HbF	fetal haemoglobin
HBF	hepatic blood flow
Hbmet	methaemoglobin
HbS	sickle haemoglobin
HbSul	sulphaemoglobin
hCG	human chorionic gonadotrophin
Hct	haematocrit
HD	haemodialysis
HDL	high-density lipoprotein
HDN	haemolytic disease of the newborn
HDU	high dependency unit
HELLP	haemolytic anaemia elevated liver enzymes low platelets
HELP	head elevating laryngoscopy pillow
HEMS	helicopter emergency medical services
HER	hepatic extraction ratio
HFJV	high-frequency jet ventilation
HIV	human immunodeficiency virus
HLA	human leukocyte-associated antigen
HME	heat and moisturiser exchanger
HMP	hexose monophosphate
HMWK	high-molecular-weight kininogen
hPL	human placental lactogen
HPV	hypoxic pulmonary vasoconstriction
HR	heart rate
I	current
I:E	inspiratory : expiratory ratio
IA	intra-arterial
IABP	intra-aortic balloon pump
IASP	International Association for the Study of Pain
IC	insular cortex
ICA	internal carotid artery
ICAM	intercellular adhesion molecule
ICD	implantable cardioverter defibrillator
ICF	intracellular fluid
ICP	intracranial pressure
ICU	intensive care unit
IDDM	insulin dependent diabetes mellitus
IgA	immunoglobulin A
IgE	immunoglobulin E
IGF	insulin-like growth factor
IgG	immunoglobulin G
iGluR	ionotropic glutamine receptor
IgM	immunoglobulin M
IHD	ischaemic heart disease
IL	interleukin
ILMA	intubating laryngeal mask airway
IM	intramuscular
IML	intermediolateral
IMV	intermittent mandatory ventilation
INR	international normalised ratio
INSTI	integrase strand transfer inhibitor
IO	intraosseous
IOP	intra-ocular pressure
IP_3	inositol triphosphate
IPPV	intermittent positive-pressure ventilation
IPSP	inhibitory postsynaptic potential
IR	infrared
IRS	insulin receptor substrate
IRV	inspiratory reserve volume
ISI	international sensitivity index
ISO	International Organization for Standardization
I_{SPTA}	spatial-peak temporal-average intensity

IT	implant tested
ITP	idiopathic thrombocytopenia purpura
IU	international unit
IUGR	intrauterine growth restriction
IV	intravenous
IVC	inferior vena cava
IVIg	intravenous immunoglobulin
IVRA	intravenous regional anaesthesia
JVP	jugular venous pressure
KCCT	kaolin clotting time
K_F	glomerular capillary coefficient
LAK	lymphokine-activated killer
LAP	left atrial pressure
LBP	lipopolysaccharide binding protein
LBP	low back pain
LC	locus coeruleus
LD_{50}	lethal dose 50%
LDL	low-density lipoprotein
LED	light-emitting diode
LH	luteinising hormone
LH-RH	luteinising hormone releasing hormone
LIS	lateral intracellular space
LMA	laryngeal mask airway
LMW	low molecular weight
LMWH	low-molecular-weight heparin
LOH	loop of Henle
LOR	loss of resistance
LOS	lower oesophageal sphincter
LSCS	lower-segment Caesarean section
LT	leukotriene
LV	left ventricle
LVEDP	left ventricular end-diastolic pressure
LVF	left ventricular failure
LVH	left ventricular hypertrophy
LVSWI	left ventricular stroke work index
M	muscarinic
M3G	morphine-3-glucuronide
M6G	morphine-6-glucuronide
MAC	minimum alveolar concentration
MAO	monoamine oxidase
MAOI	monoamine oxidase inhibitor
MAP	mean arterial pressure
MBL	mannan-binding lectin
MCA	middle cerebral artery
MCH	mean cell haemoglobin
MCV	mean cell volume
MDP	maximum diastolic potential
MEA	microwave endometrial ablation
MEFR	mid-expiratory flow rate
MEPP	miniature endplate potential
MET	metabolic equivalent (unit)
MEWS	modified early warning system
MFR	mannosyl–fucosyl receptor
MG	muscle group
MGPS	medical gas pipeline service
MH	malignant hyperthermia
MH	mechano-heat
MHC	major histocompatibility
MHRA	Medicines and Healthcare products Regulatory Agency
MI	myocardial infarction
MIA	mechanically insensitive afferent
MIC	minimum inhibitory concentration
MILS	manual in-line stabilisation
MIR	minimum infusion rate
MIRL	membrane inhibitor of reactive lysis
MIT	mono-iodotyrosine
MMC	migratory motor complex
mmHg	millimetres of mercury (pressure)
MODS	multiple organ dysfunction syndrome
MPAP	mean pulmonary arterial pressure
MR	magnetic resonance
MRI	magnetic resonance imaging
mRNA	messenger RNA
MSA	mechanically sensitive afferent
MRSA	meticillin-resistant *Staphyloccocus aureus*
MTC	major trauma centre
MTD	maximum tolerated dose
MUGA	multigated scan
MV	minute ventilation
MV	minute volume
MW	molecular weight
nAChR	nicotinic acetylcholine receptor
NADH	nicotinamide adenine dinucleotide
NADPH	nicotinamide adenine dinucleotide phosphate
NAI	non-accidental injury
NANC	non-adrenergic non-cholinergic
NAP3	National Audit Project 3
NAP4	National Audit Project 4
NAPQI	N-acetyl-p-benzo-quinone imine
NBM	nil by mouth
NCA	nurse-controlled analgesia
Nd-YAG	neodymium yttrium aluminium garnet
NG	nasogastric
NGF	nerve growth factor

NHS	National Health Service
NICE	National Institute for Health and Care Excellence
NIOSH	National Institute for Occupational Safety and Health
NiPPV	nasal intermittent positive-pressure ventilation
NIST	non-interchangeable screw thread
NK	natural killer
NK	neurokinin receptor
NKA	neurokinin A
NMBA	neuromuscular blocking agent
NMJ	neuromuscular junction
NMDA	N-methyl-D-aspartate
NMJ	neuromuscular junction
NNH	number needed to harm
NNRTI	non-nucleoside reverse transcriptase inhibitor
NNT	number needed to treat
NPSA	National Patient Safety Association
NPV	negative predictive value
NRG	nucleus reticularis gigantocellularis
NREM	non-rapid eye movement
NRM	nucleus raphe magnus
NRS	numerical rating scale
NRTI	nucleoside/nucleotide reverse transcriptase inhibitor
NSAID	non-steroidal anti-inflammatory drug
NTP	normal temperature and pressure
NTS	nucleus tractus solitarius
NV	nausea and vomiting
NWC	number of words chosen
O/G	oil/gas
O/W	oil/water
OAA	Obstetric Anaesthetists Association
OCI	oesophageal contractility index
ODC	oxyhaemoglobin dissociation curve
OP	oxidative phosphorylation
OPAC	oximetric pulmonary artery catheter
OR	odds ratio
OSA	obstructive sleep apnoea
π	osmotic pressure
P	probability
P_{50}	PO_2 at which haemoglobin is 50% saturated
PA	pulmonary artery
PABA	para-aminobenzoic acid
PAC	pulmonary artery catheter
P_ACO_2	partial pressure of carbon dioxide – alveolar
$PaCO_2$	partial pressure of carbon dioxide – arterial
PACWP	pulmonary artery capillary wedge pressure
PADP	pulmonary artery diastolic pressure
PAF	platelet activating factor
PAFC	pulmonary artery flotation catheter
PAG	periaqueductal grey
PAH	para-aminohippuric acid
PAMP	pathogen-associated molecular pattern
P_AO_2	partial pressure of oxygen – alveolar
PaO_2	partial pressure of oxygen – arterial
PARS	patient at risk score
PART	patient at risk team
PBP	penicillin-binding protein
P_C	capillary hydrostatic pressure
PCA	patient-controlled analgesia
PCA	posterior cerebral artery
PCC	prothrombinase complex concentrate
PCEA	patient-controlled epidural analgesia
PCNL	percutaneous nephrolithotomy
PCO_2	partial pressure of carbon dioxide
PCoA	posterior communicating artery
PCP	phencyclidine
PCP	*Pneumocystis* pneumonia
PCWP	pulmonary capillary wedge pressure
PD	photodiode
PDE	phosphodiesterase enzyme
PDGF	platelet-derived growth factor
PDPH	post-dural puncture headache
PE	potential energy
PE	pulmonary embolus
PEA	pulseless electrical activity
$P\bar{E}CO2$	partial pressure end-tidal carbon dioxide
PEEP	positive end-expiratory pressure
PEFR	peak expiratory flow rate
PEP	post-exposure prophylaxis
PET	positron emission tomography
PF4	platelet factor 4
PFC	perfluorocarbon
PGE	prostaglandin E
PGG	prostaglandin G
PGH	prostaglandin H
PGI	prostaglandin I
Pi	inorganic phosphate
PI	protease inhibitor
P_{IF}	interstitial hydrostatic pressure
PIH	prolactin inhibiting hormone

P_IO_2	inspired oxygen tension
PIP_2	phosphatidyl inositol bisphosphate
PIS	pin index system
PK	prekallikrein
PLOC	provoked lower oesophageal contractions
PMN	polymorphonuclear neutrophils
PNMT	phenylethanolamine N-methyl transferase
PO	per os (by mouth)
PO_2	partial pressure of oxygen
POCD	postoperative cognitive decline
PONV	postoperative nausea and vomiting
PPAR	peroxisome proliferator-activated receptor
PPF	plasma protein fraction
PPI	proton pump inhibitor
PPHN	persistent pulmonary hypertension of the newborn
ppm	parts per million
PPP	pentose phosphate pathway
PPV	positive predictive value
PPV	positive-pressure ventilation
PRH	prolactin releasing hormone
PRI	pain rating index
PRST	pressure, rate, sweating, tears
PSA	prostate-specific antigen
psi	pounds per square inch
PSVT	paroxysmal supraventricular tachycardia
PT	prothrombin time
PTC	post-tetanic count
PTFE	polytetrafluoroethylene
PTH	parathyroid hormone
PTT	partial thromboplastin time
PTTK	partial thromboplastin time with kaolin
PV	plasma volume
PV	pressure–volume
PVC	poly vinyl chloride
PVD	peripheral vascular disease
PVG	periventricular grey
PVR	pulmonary vascular resistance
Q	flow
Q	charge
$\dot{Q}$	cardiac output
QAI	quaternary ammonium ion
Qs	shunt flow
R	resistance (electrical)
R	universal gas constant
RAP	right atrial pressure
RAS	reticular activating system
RAST	radioallergosorbent test
RBC	red blood cell
RBCV	red blood cell volume
RBF	renal blood flow
RCT	randomised controlled trial
RDS	respiratory distress syndrome
Re	Reynolds number
REM	rapid eye movement
RH	relative humidity
Rh	rhesus
RIMA	reversible inhibitor of monoamine oxidase A
RMP	resting membrane potential
RMS	root mean square
RNA	ribonucleic acid
RNU	regional neurosurgical unit
ROC	receptor-operated ion channel
ROTEM	rotational thromboelastometry
RPF	renal plasma flow
RQ	respiratory quotient
rRNA	ribosomal RNA
RR	relative risk
RR	respiratory rate
RRR	relative risk reduction
RRT	renal replacement therapy
RS	respiratory system
RSI	rapid sequence induction
RT_3	reverse tri-iodothyronine
RV	residual volume
RV	right ventricle
RVM	rostral ventromedial medulla
RVSWI	right ventricular stroke work index
S/N	signal to noise ratio
SA	sinoatrial
SAD	supraglottic airway device
SAGM	saline-adenine-glucose-mannitol
SaO_2	arterial oxygen saturation
SARS	severe acute respiratory syndrome
sCJD	sporadic Creutzfeldt–Jakob disease
SD	standard deviation
SE	spin echo
SEM	standard error of the mean
SFH	stroma-free haemoglobin
SGLT	sodium-dependent glucose co-transporter
SI	stroke index
SI	Système International d'Unités (International System of Units)
SIADH	syndrome of inappropriate ADH secretion
SID	strong ion difference

SIMV	synchronised intermittent mandatory ventilation
SIRS	systemic inflammatory response syndrome
SL	semilunar
SL	sublingual
SLE	systemic lupus erythematosus
SLOC	spontaneous lower oesophageal contractions
SMP	sympathetically maintained pain
SNGFR	single-nephron glomerular filtration rate
SNP	sodium nitroprusside
SNRI	serotonin–noradrenaline reuptake inhibitor
SO_2	oxygen saturation
SPECT	single-photon emission computed tomography
SpO_2	pulse oximeter oxygen saturation
SR	sarcoplasmic reticulum
SRS-A	slow-reacting substance of anaphylaxis
SSEP	somatosensory evoked potential
SSRI	selective serotonin reuptake inhibitor
STI	sexually transmitted infection
STOP	suction termination of pregnancy
STT	spinothalamic tract
SV	spontaneous ventilation
SV	stroke volume
SVC	superior vena cava
SVI	systemic vascular index
SvO_2	mixed venous oxygen saturation
SVP	saturated vapour pressure
SVR	systemic vascular resistance
SVWI	stroke volume work index
SW	stroke work
T	absolute temperature
T	thymine
$t_{½}$	half-life
T_3	tri-iodothyronine
T_4	thyroxine
Tan	tangent
TBPA	thyroxine-binding prealbumin
TBG	thyroxine-binding globulin
TBI	traumatic brain injury
TBV	total blood volume
TBW	total body water
Tc	cytotoxic T cell
TCA	tricyclic antidepressant
TCI	target-controlled infusion
TCR	T-cell receptor
TCRE	transcervical resection of endometrium
TD	transdermal
TEG	thromboelastography
TENS	transcutaneous electrical nerve stimulation
TF	tissue factor
T_H	T helper cell
THC	terahydro-cannabinol
THR	total hip replacement
TIVA	total intravenous anaesthesia
TLC	total lung capacity
TLV	total lung volume
TNF	tumour necrosis factor
TOE	transoesophageal echocardiography
TOF	train of four
TP	threshold potential
t-PA	tissue-type plasminogen activator
TPP	thiamine pyrophosphate
TRALI	transfusion-related acute lung injury
TRH	thyrotropin releasing hormone
Trk	tyrosine kinase receptor
tRNA	transfer RNA
TRP	transient receptor potential
TRPV1	transient receptor potential vanilloid 1
TSE	transmissible spongiform encephalopathy
TSH	thyroid-stimulating hormone
TT	thrombin time
TTN	transient tachypnoea of the newborn
TUR	transurethral resection
TURBT	transurethral resection of bladder tumour
TURP	transurethral resection of the prostate
TV	tidal volume
TVT	transvaginal tension-free tape
TXA_2	thromboxane A_2
UBF	uterine blood flow
UOS	upper oesophageal sphincter
URT	upper respiratory tract
URTI	upper respiratory tract infection
USGRA	ultrasound-guided regional anaesthesia
UTP	uridine triphosphate
UV	ultraviolet
$\dot{V}$	ventilation
$\dot{V}/\dot{Q}$	ventilation/perfusion
V_A	alveolar volume
VAS	visual analogue scale
V_{BL}	blood volume
VC	vital capacity
vCJD	variant Creutzfeldt–Jakob disease
VCO_2	carbon dioxide flux

V_D	anatomical dead space
V_d	volume of distribution
VER	visual evoked response
VF	ventricular fibrillation
VIC	vaporiser inside circle
VIE	vacuum-insulated evaporator
V_{INT}	interstitial fluid volume
VIP	vasoactive intestinal peptide
VISA	vancomycin-intermediate *Staphylococcus aureus*
VLDL	very-low-density lipoprotein
VMA	vanillylmandelic acid
VO_2	oxygen uptake in the lungs
VOC	vaporiser outside circle
VPC	ventricular premature contractions
V_{PL}	plasma volume
VPN	ventral posterior nucleus of the thalamus
V_{RBC}	red blood cell volume
VRE	vancomycin-resistant enterococci
VRG	vessel-rich group
VRS	verbal rating scale
V_T	tidal volume
VT	ventricular tachycardia
V_TCO_2	volume of carbon dioxide per breath
VTE	venous thromboembolism
vWF	von Willebrand factor
WBC	white blood cell
WHO	World Health Organization
WPW	Wolff–Parkinson–White