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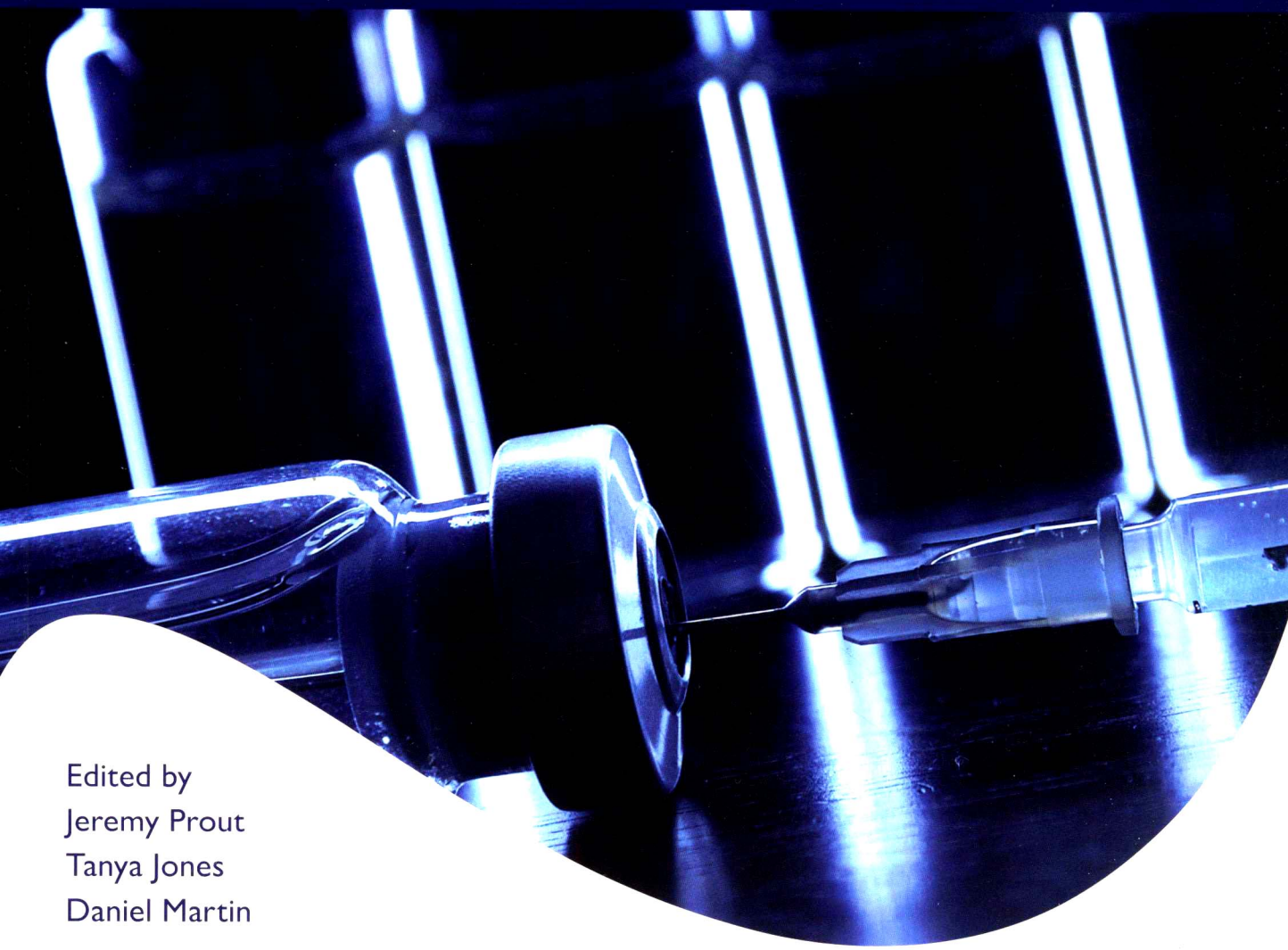

Edited by
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ADVANCED TRAINING IN ANAESTHESIA

the essential curriculum

Oxford Higher Specialty Training: Advanced Training in Anaesthesia

The Essential Curriculum

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Contents

Oxford Higher Specialty Training: Advanced Training in Anaesthesia

JP

To Maryam and Oscar, and to my parents, Joan and the late Colin.

TJ

A huge thank you to Nick Stephenson, for all the reading, patience, and support.

DM

To Georgina, and my long-suffering family and friends.

All

Also to the late Dr John Ruston, FRCA (1955–2013), Consultant Anaesthetist to the Royal Free Hospital. We miss the benefits of his wisdom and experience.

Foreword

Drs Prout, Jones, and Martin have endeavoured to provide a comprehensive reference text for all those involved in the practice and safe delivery of anaesthesia, with the direct aim of following the Royal College of Anaesthetists published syllabus for the final FRCA examination. Succinct and clearly laid out, it enables readers to build on their knowledge of basic science, and provides fresh insight into the applications of basic science applied to clinical anaesthesia. Modern anaesthesia encompasses vast topics, and although a relatively young medical specialty, change is inevitable. The wealth of knowledge in medicine and how this impacts on the safe delivery of anaesthesia expands exponentially. The FRCA syllabus for examinations in anaesthesia is now clearly defined, but this is just the beginning. Interpretation and emphasis is always going to need guidance, and the authors have aspired to provide that guidance.

The book is divided into two main categories: the first is dedicated to applied basic science, and is followed by the application of basic science into clinical anaesthesia. This is exactly the stance taken by the Royal College of Anaesthetists with the final FRCA examination. The book is thoughtfully laid out, with very clear subject headings, in which information on clinical topics is easily available. It provides practical advice, based on sound physiology and pathophysiology to provide guidance for the safe delivery of modern anaesthesia, in the context of patients with much co-morbid disease. Appropriate references are provided at the end of each chapter for further in depth reading.

With the ageing population, anaesthesia will be required for an increasing number of individuals, with an ever expanding array of inherited and acquired conditions. Preoperative risk analysis features prominently in the chapters, with a commitment to optimising the medical conditions of the patient prior to anaesthesia and surgery. Recommendations for levels of monitoring go hand in hand with the choice of anaesthetic techniques for delivering safe anaesthesia, in order to ensure the best possible outcome for patients.

This is a concise reference text for revision purposes. It enables readers to build on their academic knowledge, and provides fresh insight into the applications of basic science relevant to safe clinical anaesthesia. The inclusion of over seventy enthusiastic young authors has ensured modern interpretation, and brought both great diversity and lateral thought to the book.

The book will be indispensable for candidates involved in sitting the final FRCA examination. Interestingly, it will also be of great value to those of us who sat the examination some time ago. Access to information in the 21st century is instant, but appropriate emphasis is always going to need guidance.

We have come a long way since W.T.G. Morton, William Squire, John Snow, and Joseph Clover began giving ether and chloroform to allow surgical intervention without time constraint. I am sure that they would all be amazed by the increasingly sophisticated and precise administrations of the modern speciality, particularly as it is delivered to so many people with such diverse conditions of ill-health.

Advanced Training in Anaesthesia will successfully complement other key medical texts as a reference guide that will be indispensable to those involved in the safe delivery of anaesthesia to an increasingly aged and co-morbid population.

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Preface

The principal aim of this book is to assist candidates preparing for final examinations in anaesthesia, both in the UK and elsewhere.

We very much hope, however, that the book will find a place beyond the requirements of exam preparation. We have tried to produce a stand-alone account of the essentials of our specialty and its subspecialties that will provide a ready source of reference in most situations.

The Final FRCA (Fellowship of the Royal College of Anaesthetists) examination in the UK is a major hurdle in anaesthetic training, representing the highest professional qualification in the specialty and the gateway to specialist training at an advanced level.

The book attempts to follow closely the recently revised college syllabus, published in August 2010.[1] The syllabus is extensive, comprising both applied basic sciences, and the clinical practice of anaesthesia, intensive care, and pain management. Any subject listed in the syllabus may appear in the examination: we have, therefore, adhered to it closely and attempted to be comprehensive in our presentation of topics.

This book aims to cover the required knowledge in the necessary detail, and is designed as a companion volume to *Training in Anaesthesia: The Essential Curriculum*, published by Oxford University Press in 2010 and which is aimed at the Primary FRCA. Knowledge of the Primary syllabus is assumed by the Final examiners and is often a stumbling block in the Final examination.

It cannot be stressed too highly that pure basic science topics are frequently examined in the Final FRCA, and candidates would be most unwise not to take account of this during their revision. Together, the two volumes are intended to be a comprehensive guide to the FRCA examination.

In this volume, topics in applied basic science are presented in a systems-based format as laid out in the college syllabus. The sections that follow cover all the major clinical subspecialties. The double-page spread is intended to provide a succinct format for learning, yet containing all the important detail.

References and suggestions for further reading from the recent literature are included for readers who wish to explore subjects in more depth.

The editors have been fortunate to recruit both distinguished contributors who are leaders in their field, but also trainees—who have made an important contribution to ensure that the resulting information meets their needs.

We are hugely grateful to everyone at Oxford University Press, most especially to Christopher Reid who offered such encouragement after our initial approach, to Fiona Richardson and Geraldine Jeffers who displayed powers of extreme patience (sorely tested!) whilst awaiting the manuscript, and to Abigail Stanley and Jane Williams for seeing the project through to publication and beyond.

We hope that this will be the first of many editions and look forward to your feedback such that future editions can evolve according to the needs and wishes of the readership we seek to serve.

Jeremy Prout
Tanya Jones
Daniel Martin
London 2013

[1] www.rcoa.ac.uk/system/files/TRG-CCT-ANNEXC.pdf

Abbreviations

6MWT	Six-minute walk test
AAA	Abdominal aortic aneurysm
AAGBI	Association of Anaesthetists of Great Britain and Ireland
AASM	American Academy of Sleep Medicine
ABG	Arterial blood gas
ABPM	Ambulatory blood pressure monitoring
ACC	American College of Cardiology
ACEI	Angiotensin converting enzyme inhibitor
ACT	Activated clotting time
ACTH	Adrenocorticotrophic hormone
ADH	Anti-diuretic hormone
ADP	Adenosine diphosphate
ADQI	Acute dialysis quality initiative
AED	Antiepileptic drug
AEP	Auditory evoked potential
AF	Atrial fibrillation
AFOI	Awake fibreoptic intubation
AG	Anion gap
AHA	American Heart Association
AHI	Apnoea-hypopnoea index
AKI	Acute kidney injury
ALA	Aminolaevulinic acid
ALS	Advanced Life Support
cAMP	cyclic adenosine monophosphate
ANP	Atrial natriuretic peptide
ANS	Autonomic nervous system
AP	Anteroposterior
APACHE	Acute Physiology and Chronic Health Evaluation
APC	Activated protein C
APH	Antepartum haemorrhage
APTT	Activated partial thromboplastin time
AR	Absolute risk
ARR	Absolute risk reduction
ARA	Angiotensin receptor antagonist
ARDS	Acute respiratory distress syndrome
ARVD	Arrhythmogenic right ventricular dysplasia
ASA	American Society of Anesthesiologists
ASD	Atrial septal defect
AT	Anaerobic threshold *or* antithrombin *or* angiotesin
ATLS	Advanced Trauma Life Support
ATN	Acute tubular necrosis
ATP	Adenosine triphosphate
AV	Atrioventricular
AVN	AV node/nodal
AVNRT	AV nodal re-entrant tachycardia
BiPAP	Bi-level positive airways pressure
BMR	Basal metabolic rate
BNP	Brain natriuretic peptide
BP	Blood pressure
BPEG	British Pacing and Electrophysiology Group
BPF	Bronchopleural fistula
BTS	British Thoracic Society
CABG	Coronary artery bypass grafting
CAC	Coronary artery calcium
CAD	Coronary artery disease
CARP	Coronary Artery Revascularisation Prophylaxis
CATS	Childrens' Acute Transport Service (UK)
CCB	Calcium channel blocker
CCF	Congestive cardiac failure
CCO	Critical care outreach
CCOM	Continuous cardiac output monitoring
CCTA	Coronary CT angiography
CHD	Congenital heart disease
CI	Confidence interval
CICV	Can't intubate, can't ventilate
CIN	Contrast-induced nephropathy
CMAP	Compound muscle action potential
CMRI	Coronary MRI
$CMRO_2$	Cerebral metabolic rate of oxygen consumption
CMV	Cytomegalovirus
CNS	Central nervous system
CO	Cardiac output *or* carbon monoxide
CO_2	Carbon dioxide
COPD	Chronic obstructive pulmonary disease
COX	Cyclo-oxygenase
CPAP	Continuous positive airways pressure
CPB	Cardiopulmonary bypass
CPET	Cardiopulmonary exercise testing
CPP	Cerebral perfusion pressure
CRBSI	Catheter-related bloodstream infection
CRMD	Cardiac rhythm management device
CRP	C-reactive protein
CRT	Cardiac resynchronization therapy

CSE	Combined spinal epidural
CSF	Cerebrospinal fluid
CT	Computed tomography
CTPA	Computed tomography pulmonary angiography
CVC	Central venous catheter
CVP	Central venous pressure
CVS	Cardiovascular system
CW	Continuous wave
CXR	Chest X-ray
DAS	Difficult Airway Society
DASI	Duke Activity Status Index
DC	Direct current
DCM	Dilated cardiomyopathy
DHCA	Deep hypothermic circulatory arrest
DI	Diabetes insipidus
DIC	Disseminated intravascular coagulation
DNA	Deoxyribonucleic acid *or* Did not attend
DPP	Dipeptidyl peptidase
DPPC	Dipalmitoyl phosphatidylcholine
DSE	Dobutamine stress echocardiography
DVT	Deep vein thrombosis
EACA	Epsilon-aminocaproic acid
EBV	Epstein–Barr virus
ECF	Extracellular fluid
ECG	Electrocardiogram
ECHO	Echocardiography
ECT	Electroconvulsive therapy
EDV	End-diastolic volume
EEG	Electroencephalogram
ELISA	Enzyme-linked immunosorbent assay
EMG	Electromyogram
EMI	Electromagnetic interference
ENT	Ear, nose, and throat
ERCP	Endoscopic retrograde cholangiopancreatography
ERPC	Evacuation of retained products of conception
ESA	European Society of Anaesthesiology
ESC	European Society of Cardiology
ESLD	End-stage liver disease
ESRD	End-stage renal disease
ETT	Endotracheal tube
EVAR	Endovascular aneurysm repair
EVD	External ventricular drain
EVLW	Extravascular lung water
EWS	Early warning score
FBC	Full blood count
FEV_1	Forced expiratory volume in one second
FFP	Fresh frozen plasma
FMV	Facemask ventilation
FNA	Fine needle aspiration
FRC	Functional residual capacity
FT	Flow time
FVC	Forced vital capacity
GA	General anaesthesia
GABA	γ-aminobutyric acid
GCS	Glasgow Coma Scale
GEDV	Global end-diastolic volume
GFR	Glomerular filtration rate
GI	Gastrointestinal
GIFTASUP	Guidelines on intravenous fluid therapy in adult surgical patients
GLP	Glucagon-like peptide
cGMP	cyclic guanosine monophosphate
GORD	Gastro-oesophageal reflux disease
Gp	Glycoprotein
G6PD	Glucose-6-phosphate dehydrogenase
GCSE	Generalised convulsive status epilepticus
GTN	Glyceryl trinitrate
GTP	Guanosine triphosphate
GUCH	Grown-up congenital heart disease
HAPE	High altitude pulmonary oedema
Hb	Haemoglobin
HCM	Hypertrophic (obstructive) cardiomyopathy
HDL	High density lipoprotein
HDU	High dependency unit
HES	Hydroxyethyl starch
HFO	High-frequency oscillation
HFPEF	Heart failure with preserved ejection fraction
HFREF	Heart failure with reduced ejection fraction
HIT	Heparin-induced thrombocytopenia
HOPE	Heart Outcomes Prevention Evaluation
HPA	Hypothalamic–pituitary–adrenal (axis)
HR	Heart rate
HRT	Hormone replacement therapy
5-HT	5-hydroxytryptamine
IABP	Intra-aortic balloon pump
IAP	Intra-abdominal pressure
ICD	Implantable cardioverter defibrillator
ICF	Intracellular fluid
ICP	Intracranial pressure
ICRP	International Commission on Radiological Protection
ICS	Intraoperative cell salvage *or* Intensive Care Society
IHD	Ischaemic heart disease
IL	Interleukin
INR	International normalized ratio
IOP	Intraocular pressure
IPPV	Intermittent positive pressure ventilation
ISWT	Incremental shuttle walk test
ITU	Intensive therapy unit
IV	Intravenous
IVC	Inferior vena cava
LA	Local anaesthetic
LAD	Left anterior descending (coronary artery)
LAP	Left atrial pressure
LASER	Light amplification by stimulated emission of radiation
LAUP	Laser-assisted uvuloplasty
LBBB	Left bundle branch block
LDL	Low density lipoprotein

LED	Light-emitting diode
LFTs	Liver function tests
LiDCO	Lithium dilution cardiac output
LIMA	Left internal mammary artery
LMWH	Low-molecular-weight heparin
LODS	Logistic Organ Dysfunction Score
LOS	Lower oesophageal sphincter
LV	Left ventricular
LVAD	Left ventricular assist device
LVEDP	Left ventricular end-diastolic pressure
LVEDV	Left ventricular end-diastolic volume
LVEF	Left ventricular ejection fraction
LVH	Left ventricular hypertrophy
LVOT	Left ventricular outflow tract
MAP	Mean arterial pressure
MA	Mean acceleration
MAP	Mean arterial pressure
MELD	Model for end-stage liver disease
MEP	Motor evoked potential
MET	Metabolic equivalent (of task)
MEWS	Modified early warning system
MI	Myocardial infarction
MIBG	Meta-iodobenzylguanidine
MILS	Manual in-line stabilization
MODS	Multiple Organ Dysfunction Score
MOF	Multiple organ failure
MPAP	Mean pulmonary artery pressure
MPI	Myocardial perfusion imaging
MPM	Mortality Prediction Model
MRI	Magnetic resonance imaging
NAP	National Audit Project
NASPE	North American Society of Pacing and Electrophysiology
NBM	Nil by mouth
NCEPOD	National Confidential Enquiry into Patient Outcome and Death
NGT	Nasogastric tube
NICE	National Institute for Health and Clinical Excellence
NIV	Non-invasive ventilation
NHS	National Health Service (UK)
NMBA	Neuromuscular blocking agent
NMDA	N-methyl-D-aspartic acid
NNT	Number needed to treat
NO	Nitric oxide
NOD	Nucleotide oligomerization domain
NOS	Nitric oxide synthetase
NPSA	National Patient Safety Agency
NREM	Non-rapid eye movement
NS	Normal saline
NSAID	Non-steroidal anti-inflammatory drug
NSTEMI	Non ST-elevation myocardial infarction
NSVT	Non-sustained ventricular tachycardia
NTS	Nucleus (of) tractus solitarius
NYHA	New York Heart Association
ODM	Oesophageal Doppler monitor
OLV	One lung ventilation
OPCAB	Off-pump coronary artery bypass
OR	Odds ratio
OSA	Obstructive sleep apnoea
PA	Pulmonary artery
PAC	Pulmonary artery catheter
PAO_2	Alveolar partial pressure of oxygen
PaO_2	Arterial partial pressure of oxygen
PAP	Pulmonary artery pressure
PAH	Pulmonary arterial hypertension
PAOP	Pulmonary artery occlusion pressure
PCA	Patient-controlled analgesia
PCEA	Patient-controlled epidural analgesia
PCI	Percutaneous coronary intervention
PDA	Patent ductus arteriosus or posterior descending (coronary) artery
PDEI	Phosphodiesterase inhibitor
PDPH	Post-dural puncture headache
PE	Pulmonary embolism
PEA	Pulseless electrical activity
PEEP	Positive end-expiratory pressure
PFO	Patent foramen ovale
PHT	Pulmonary hypertension
PICC	Peripherally-inserted central catheter
PiCCO	Pulse contour cardiac output
PICU	Paediatric intensive care unit
PMN	Polymorphonuclear neutrophil
PMP	Pain management programme
PND	Paroxysmal nocturnal dyspnoea
PNI	Peripheral nerve injury
PNS	Parasympathetic nervous system
POCT	Point of care testing
POISE	PeriOperative Ischaemia Study Evaluation
POMS	Postoperative Morbidity Survey
PONV	Postoperative nausea and vomiting
POSSUM	Physiological and Operative Severity Score for Enumeration of Mortality and Morbidity
PPCM	Peripartum cardiomyopathy
PPHN	Persistent pulmonary hypertension of the newborn
PPV	Pulse pressure variation
PRCs	Packed red cells
PRES	Posterior reversible encephalopathy syndrome
PRR	Pattern recognition receptor
PT	Prothrombin time
PTFE	Polytetrafluoroethylene
PV	Peak velocity
PVR	Pulmonary vascular resistance
PVB	Paravertebral block
PVR	Pulmonary vascular resistance
PW	Pulsed wave
RAAA	Ruptured abdominal aortic aneurysm
RAAS	Renin–angiotensin–aldosterone system
RCoA	Royal College of Anaesthetists (UK)
RCM	Restrictive cardiomyopathy

RCT	Randomized controlled trial
RCV	Red cell volume
REM	Rapid eye movement
RFTs	Respiratory function tests
RIFLE	Risk-Injury-Failure-Loss-Endstage
RIG-1	Retinoic acid-inducible gene-1
RIJV	Right internal jugular vein
ROC	Receiver operating curve
ROS	Reactive oxygen species
ROTEM®	Rotational thromboelastometry
RR	Relative risk
RRR	Relative risk reduction
RRT	Renal replacement therapy *or* rapid response team
RS	Respiratory system
RSI	Rapid sequence induction
RV	Right ventricular
RVOT	Right ventricular outflow tract
SAH	Subarachnoid haemorrhage
SAM	Systolic anterior motion
SAPS	Simplified Acute Physiology Score
SBP	Systolic blood pressure
SCD	Sudden cardiac death
SCI	Spinal cord injury
SIADH	Syndrome of inappropriate antidiuretic hormone (secretion)
SID	Strong ion difference
SIRS	Systemic inflammatory response syndrome
SLE	Systemic lupus erythematosus
SNS	Sympathetic nervous system
SR	Systematic review
SSRI	Selective serotonin reuptake inhibitor
SOB	Shortness of breath
SOFA	Sequential Organ Failure (score)
SSEP	Somatosensory evoked potential
SSRI	Selective serotonin reuptake inhibitor
STEMI	ST-elevation myocardial infarction
SvO_2	Mixed venous oxygen saturation
SV	Stroke volume
SVR	Systemic vascular resistance
SVV	Stroke volume variation
TBI	Traumatic brain injury
TBSA	Total body surface area
TCA	Tricyclic antidepressant
TCI	Target controlled infusion
TEBI	Thoracic electrical bioimpedance
TEBR	Thoracic electrical bioreactance
TEG®	Thromboelastography
TF	Tissue factor
TFPI	Tissue factor pathway inhibitor
TGA	Transposition of the great arteries
TIA	Transient ischaemic attack
TIPS	Transjugular intrahepatic portosystemic shunt
TIVA	Total intravenous anaesthesia
TLC	Total lung capacity
TLR	Toll-like receptor
TNF	Tumour necrosis factor
TOE	Transoesophageal echocardiography
ToF	Train of four
tPA	Tissue plasminogen activator
TPN	Total parenteral nutrition
TPDT	Transpulmonary dilutional technique
TPN	Total parenteral nutrition
TSH	Thyroid-stimulating hormone
TTE	Transthoracic echocardiography
TUR	Transurethral resection
UA	Unstable angina
UFH	Unfractionated heparin
UPPP	Uvulo-palato-pharyngoplasty
VAD	Ventricular assist device
VATS	Video-assisted thoracoscopic surgery
VF	Ventricular fibrillation
VKA	Vitamin K antagonist
VMA	Vannilyl mandelic acid
VOTO	Ventricular outflow obstruction
VRII	Variable rate insulin infusion
VSD	Ventricular septal defect
VT	Ventricular tachycardia *or* ventilatory threshold
VTE	Venous thromboembolism
vWF	Von Willebrand's factor
WHO	World Health Organization

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Contents