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Edited by Andrew Klein, Alain Vuylsteke and Samer A. M. Nashef

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Core Topics in Cardiothoracic Critical Care

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Preface

In the corner, a patient is recovering well after a heart operation. Even so, the lights of five infusion pumps are blinking regularly, the ventilator is sighing, the electrocardiograph, several pressures, temperature and oxygen saturation are continuously displayed and massive amounts of data are being generated and recorded, and this is when things are going well!

Elsewhere, another patient may be on an intra-aortic balloon pump, a third may be on haemofiltration, a fourth may be on a ventricular assist device and occasionally, behind drawn curtains, a mad-eyed surgeon may be performing open heart surgery on the unit due to unexpected complications.

The cardiothoracic critical care area can be a frightening place indeed.

Don't panic!

Managing the critically ill cardiothoracic patient is no different from any other patient. The principles of good clinical practice apply here as they do elsewhere. Knowing the history helps. Clinical examination, as in every field of medicine, yields valuable information.

However, critical care provides additional, hard clinical data like no other area of medical practice. Continuous and regular monitoring of physiological and haematological parameters makes most diagnoses easy to make. If there is still doubt about the status of the patient, further information is easy to obtain, whether by pulmonary artery flotation catheter, transoesophageal echocardiography or computed tomography. This is one area where most decisions are made on the basis of sound evidence rather than on a clinical hunch. All that is required is some basic knowledge, a degree of thoroughness and sound judgment.

This book aims to guide caregivers from all disciplines in the management of cardiothoracic patients during their time in the critical care environment. The work is not exhaustive nor, we hope, exhausting. It is written by experts in their fields and its primary aims are to explain and demystify the approach to various areas of cardiothoracic critical care.

We truly believe the topic of cardiothoracic critical care can be accessible and easy to learn. We hope, with this book, to have made it more so.

Thanks also to Graham Hilton for photographs, including the cover.

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Editors*

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Foreword

Cardiac intensive care is a peculiarity in the United Kingdom. In many hospitals, it is the only single specialty critical care area. We should not be too surprised at this; cardiac disease is common and its frequency has spawned many new and innovative treatments. Changes in the organization of our hospitals may mean more patients with cardiac disease are treated in specialist centres and even fewer seen in general intensive care units, thus reducing the skill base and so comfort of many intensivists in managing these patients. Patients do not just present with heart disease, they also require surgery for other problems and familiarity with cardiac support is essential for all who work in general units.

This is not an in-depth tome, but rather a practical text full of the kind of tricks of the trade that make a skilled cardiac intensivist. One potential problem of

a single specialty unit is a tendency to “forget” about the other systems; these are all addressed herein, along with other essential elements such as ethics and the running of a successful unit.

This is a welcome text targeting a multi-disciplinary audience. It will be useful for those approaching an attachment to a cardiac unit as well as for those of us outside who want to update ourselves on the latest treatments available.

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Abbreviations

A		APC	Activated protein C
A-	Angiotensin	aPTT	Activated partial thromboplastin time
ABG	Arterial blood gas	ARDS	Acute respiratory distress syndrome
ACE	Angiotensin-converting enzyme	ARF	Acute renal failure
ACEI	Angiotensin-converting enzyme inhibitor	ASV	Adaptive support ventilation
ACLS	Advanced cardiac life support	A_{sys}	Area under the systolic fraction
ACS	Abdominal compartment syndrome	AT	Antithrombin
ACT	Activated coagulation time	ATG	Antithymocyte globulin
ACTA	Association of Cardiothoracic Anaesthetists	ATN	Acute tubular necrosis
ACTH	Adrenocorticotrophic hormone	AUC	Area under the curve
ACV	Assist-control ventilation	AV	Atrioventricular
ADL	Activity of daily living	B	
ADP	Adenosine diphosphate	BAEP	Brainstem auditory evoked potentials
AED	Automatic external defibrillator	BiPAP	Bi-level positive airway pressure, bi-level pressure assist
AEP	Auditory evoked potential	BIS	Bispectral (index)
AF	Atrial fibrillation	BIVAD	Biventricular assist device
AIDS	Acquired immunodeficiency syndrome	BLS	Basic life support
ALI	Acute lung injury	BMI	Body mass index
ALS	Advanced life support	BMR	Basal metabolic rate
ANH	Acute normovolaemic haemodilution	BPF	Bronchopleural fistula
AP	Anteroposterior	bpm	Beats per minute
APACHE	Acute Physiology and Chronic Health Evaluation	BUN	Blood urea nitrogen

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ABBREVIATIONS

C		CVP	Central venous pressure
CABG	Coronary artery bypass graft	CVVH	Continuous venovenous haemofiltration
CAM-ICU	Confusion assessment method for the intensive care unit	CVVHD	Continuous venovenous haemodialysis
cAMP	Cyclic adenosine monophosphate	CVVHDF	Continuous venovenous haemodiafiltration
CBF	Cerebral blood flow	Cx	Circumflex artery (coronary artery)
CCO	Continuous measurements of cardiac output	CYP3A4	Cytochrome microsomal system isoform 3A4
CCP	Critical care practitioner	D	
CCT	Certificate of completion of training	DC	Direct current
CDC	Centers for Disease Control and Prevention (USA)	DDAVP	Desmopressin (1-desamino-8-D-arginine vasopressin)
CF	Cystic fibrosis	DHCA	Deep hypothermic circulatory arrest
CI	Cardiac index Confidence interval	DIC	Disseminated intravascular coagulation
CIS	Clinical information system	DL_{CO}	Transfer coefficient for carbon monoxide
CML	Chronic myelomonocytic leukaemia	DNAR	Do not attempt resuscitation
CMRO₂	Cerebral metabolic rate (for oxygen)	DR	Direct radiography
CMV	Controlled mechanical ventilation Cytomegalovirus	DST	Down slope time
CNS	Central nervous system	DVT	Deep venous thrombosis
CO	Cardiac output	E	
CoA	Coarctation of the aorta	EAA	Excitatory amino acid
CoBaTriCE	Competency based training for intensive care medicine	EBM	Evidence-based medicine
COPD	Chronic obstructive pulmonary disease	ECG	Electrocardiograph
COX	Cyclo-oxygenase	ECMO	Extracorporeal membrane oxygenation
CPAP	Continuous positive airway pressure	ECT	Ecarin clotting time
CPB	Cardiopulmonary bypass	EDIC	European Diploma in Intensive Care
CPOE	Computer-aided physician order entry	EDTA	Ethylenediamine tetra-acetic acid
CPP	Cerebral perfusion pressure	EDV	End-diastolic volume
CPR	Cardiopulmonary resuscitation	EEG	Electroencephalograph
CR	Computed radiography	EF	Ejection fraction
CRBSI	Catheter-related bloodstream infection	EHR	Electronic health record
CSF	Cerebrospinal fluid	EJV	External jugular vein
CT	Computed tomogram/tomography	EMR	Electronic medical record
CTEPH	Chronic thromboembolic pulmonary hypertension	EPAP	Expiratory positive airway pressure
CVA	Cerebrovascular accident	EPO	Erythropoietin

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ABBREVIATIONS

EQ-5D	EuroQoL five-dimension	HFV	High frequency ventilation
ESR	Erythrocyte sedimentation rate	HIT	Heparin-induced thrombocytopenia
ETco₂	End-tidal CO ₂	HLA	Human leukocyte antibody
EVLW	Extravascular lung water	HMT	Heparin management test
EWS	Early warning scores	HP	Haemoperfusion
		HPA	Human platelet antigen
F		HR	Heart rate
FEV₁	Forced expiratory volume in 1 second	HRQOL	Health-related quality of life
FFD	Film to focus distance	I	
FFP	Fresh-frozen plasma	IABP	Intra-aortic balloon pump
FG	Filtration gradient	IAH	Intra-abdominal hypertension
Fio₂	Fraction of inspired oxygen	IAP	Intra-abdominal pressure
FRC	Functional residual capacity	IBTICM	Intercollegiate Board for Training in Intensive Care Medicine
G		ICA	Internal carotid artery
GABA	γ-Aminobutyric acid	ICAM	Intercellular adhesion molecule
GCS	Glasgow Coma Scale	ICD	Implantable cardiac defibrillator
G-CSF	Granulocytes colony stimulating factor	ICP	Intracranial pressure
GEDV	Global end-diastolic volume	ICU	Intensive care unit
GFR	Glomerular filtration rate	IE	Infective endocarditis
GI	Gastrointestinal	IFN	Interferon
GTN	Glyceryl trinitrate	Ig	Immunoglobulin
H		IHD	Intermittent haemodialysis
HADS	Hospital anxiety and depression scale	IJV	Internal jugular vein
Hb	Haemoglobin	IL	Interleukin
HBOC	Haemoglobin-based oxygen carriers	IMV	Intermittent mandatory ventilation
Hb-S	Haemoglobin S	INR	International Normalized Ratio
HCSW	Health care support worker	IPAP	Inspiratory positive airway pressure
HDU	High-dependency unit	IPD	Intermittent peritoneal dialysis
HF	Haemofiltration	IPF	Idiopathic pulmonary fibrosis
HFFI	High frequency flow interruption	IPPV	Intermittent positive-pressure ventilation
HFJV	High frequency jet ventilation	IRV	Inverse ratio ventilation
HFOV	High frequency oscillatory ventilation	ISHLT	International Society of Heart and Lung Transplantation
HFPV	High frequency percussive ventilation	ISI	International Sensitivity Index
HFPV	High frequency percussive ventilation	IT	Information technology
HFPV	High frequency percussive ventilation	ITBV	Intrathoracic blood volume
HFPV	High frequency percussive ventilation	ITP	Idiopathic thrombocytopenic purpura
HFPV	High frequency percussive ventilation	ITTV	Intrathoracic thermal volume

ABBREVIATIONS

ITU	Intensive therapy unit	MI	Myocardial infarction
IV	Intravenous	MIDCAB	Minimally invasive direct coronary artery bypass
IVC	Inferior vena cava	MMV	Mandatory minute ventilation
K		MOD	Multiorgan dysfunction
K	Clearance	MOF	Multiorgan (system) failure
K_m	Membrane coefficient	MPAP	Mean pulmonary artery pressure
KPS	Karnofsky performance status	MRI	Magnetic resonance imaging
L		MRSA	Methicillin-resistant <i>Staphylococcus aureus</i>
LAD	Left anterior descending (coronary artery)	MTT	Mean transit time
LAP	Left atrial pressure	MU	Million units
LCP	Liverpool Care Pathway for Dying Patients	N	
LDH	Lactate dehydrogenase	NEEP	Negative end-expiratory pressure
LIMA	Left internal mammary artery	NF- κ B	Transcription factor nuclear factor κ B
LMS	Left main stem (coronary artery)	NHP	Nottingham Health Profile
LMWH	Low-molecular-weight heparin	NIRS	Near-infrared spectroscopy
LOS	Length of stay	NIV	Noninvasive ventilation
LPS	Lipopolysaccharide	NK	Natural killer (cells)
LSV	Long saphenous vein	NMDA	<i>N</i> -methyl-D-aspartate
LV	Left ventricle/ventricular	NSAID	Nonsteroidal anti-inflammatory drug
LVAD	Left ventricular assist device	NSE	Neuron-specific enolase
LVEDP	Left ventricular end-diastolic pressure	NYHA	New York Heart Association
LVEDV	Left ventricular end-diastolic volume	P	
LVRS	Lung volume reduction surgery	PA	Pulmonary artery
M		PAC	Pulmonary artery catheter
MAP	Mean arterial pressure	Paco ₂	Carbon dioxide alveolar pressure
MCA	Middle cerebral artery	PACS	Picture archiving and communication system
MCAEP	Midcortical auditory evoked potentials	PADP	Pulmonary arterial diastolic pressure
MCP	Monocyte chemotactic protein	PAF	Platelet activating factor
MDD	Major depressive disorder	PAH	Pulmonary arterial hypertension
MDE	Major depressive episode	PAMP	Pathogen-associated molecular patterns
MDT	Multidisciplinary team	Pao ₂	Oxygen alveolar pressure
MEP	Motor evoked potential	PAP	Pulmonary artery pressure
MET	Medical emergency team	PC	Personal computer
MEWS	Modified early warning scores		Pericardial collection
MHC	Major histocompatibility complex		Protein C

ABBREVIATIONS

PCA	Patient-controlled analgesia	R	
PCI	Percutaneous coronary intervention	RA	Right atrium/atrial
PCP	<i>Pneumocystis carinii</i>	RATG	Rabbit antithymocyte globulin
PCR	Polymerase chain reaction	RBC	Red blood cell
PCV	Pressure-controlled ventilation	RCA	Right coronary artery
PCWP	Pulmonary artery wedge pressure	RFID	Radiofrequency identification
PD	Peritoneal dialysis	RIJ	Right internal jugular
PDE	Phosphodiesterase	RRT	Renal replacement therapy
PDMS	Patient data management system	RSTP	Risk score for transport patient
PE	Pulmonary embolus/embolism	RV	Right ventricle/ventricular
PEA	Pulmonary endarterectomy	RVAD	Right ventricular assist device
PEEP	Positive end-expiratory pressure		
PEG	Percutaneous endoscopic gastroscopy	S	
PHT	Pulmonary hypertension	SAH	Subarachnoid haemorrhage
PICC	Peripherally inserted central catheter	SAM	Systolic anterior motion (of the anterior mitral leaflet)
PMN	Polymorphonuclear neutrophils	Sao ₂	Arterial oxygen saturation
Po ₂	partial pressure of oxygen	SBT	Spontaneous breathing trial
POC	Point of care	s/c	Subcutaneous
PPE	Personal protective equipment	SC	Membrane sieving coefficient
PPH	Primary pulmonary hypertension	Scvo ₂	Central venous oxygen saturation
PPV	Pulse pressure variation	SCUF	Slow continuous ultrafiltration
PRBC	Packed red blood cells	SDD	Selective decontamination of digestive tract
PRVC	Pressure-regulated volume-controlled ventilation	SF-36	Short Form Health Survey
PSV	Pressure-support ventilation	SI	Système Internationale
PT	Prothrombin time	SIMV	Synchronized intermittent mandatory ventilation
PTP	Proximal tubular pressure	SIRS	Systemic inflammatory response syndrome
PTT	Partial thromboplastin time		
PTSD	Post-traumatic stress disorder	S _{JV} O ₂	Jugular venous oxygen saturation
PTV	Pulmonary thermal volume	SNP	Sodium nitroprusside
PVAD	Paracorporeal ventricular assist device	SOFA	Sequential Organ Failure Assessment
Pvco ₂	Pulmonary venous CO ₂	SPV	Systolic pressure variation
PVR	Pulmonary vascular resistance	SSEP	Somatosensory evoked potential
		SSRIs	Selective serotonin reuptake inhibitors
Q		STS	Society of Thoracic Surgeons (risk scoring)
Q _b	Blood flow	SV	Stroke volume
Q _d	Dialysis flow	SVC	Superior vena cava
Q _f	Filtration flow	Svo ₂	Mixed venous oxygen saturation
QOL	Quality of life		

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ABBREVIATIONS

SVR	Systemic vascular resistance	TRS	Toronto Risk Score
SVT	Supraventricular tachycardia	TSH	Thyroid-stimulating hormone
SWG	Standard Wire Gauge	TTE	Transthoracic echocardiography
		UF	Ultrafiltration
T		UTI	Urinary tract infection
TAH	Total artificial heart		
TAT	Thrombin–antithrombin complex	V	
Tc	Lymphocytes T cytotoxic	VAD	Ventricular assist device
TCD	Transcranial Doppler	VALI	Ventilator-associated lung injury
TEG	Thromboelastogram/ thromboelastography	VAS	Visual analog scale
TFPI	Tissue factor pathway inhibitor	VATS	Video-assisted thoracoscopic surgery
Th	Lymphocytes T helpers	Vco₂	Total volume of CO ₂ exhaled over a defined period
TLR	Toll-like receptor	VF	Ventricular fibrillation
TMP	Transmembrane pressure	VILI	Ventilator-induced lung injury
TNF	Tumor necrosis factor	Vo₂	Oxygen consumption
TOE	Transoesophageal echocardiography	V/Q	Ventilation–perfusion
TPN	Total parenteral nutrition	VT	Ventricular tachycardia
TRALI	Transfusion-related acute lung injury	vWF	von Willebrand factor
TREM-1	Triggering receptor expressed on myeloid cells		
TRIM	Transfusion-related immunomodulation	W	
		WCC	White cell count