INTERNAL MEDICINE: Critical Care

TEXTBOOK

Edited by O.Ya. BABAK, O.M. BILOVOL

RECOMMENDED
by the Academic Board of Kharkiv National Medical University as a textbook for students of higher education establishments — medical universities, institutes and academies

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The "Internal Medicine: Critical Care" provides the depth and breadth of coverage that reflects the complexity and expertise needed to practice emergency medicine successfully in today's fast—paced environments. It is an important contemporary clinical emergency care resource for students of higher education eshtablishments — medical universities, institutes and academies.

The textbook was published in the English language, illustrated with pictures and tables, which are easy to learn and to store in memory for a long time. This textbook also gives possibility to find answers quickly when you are faced with a difficult diagnosis or need the latest treatment recommendations, step-by-step guidelines and new pharmacologic considerations.

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Contents

Abbreviations

AAE acquired angioedemoedema
ABG artery bypass graft
ABG test arterial blood gas test
ACC American College of Cardiology
ACE angiotensin-converting enzyme
ACE-inhibitor, ACEI angiotensin-converting enzyme inhibitor
ACLS advanced cardiac life support
ACS acute coronary syndrome
ACTH adrenocorticotropic hormone
ADQI acute dialysis quality initiative
AED automated external defibrillator
AF atrial fibrillation
AFL atrial flutter
AHA American Heart Association
AKI acute kidney injury
ALT alanine aminotransferase
AMI acute myocardial infarction
ANCA antineutrophil cytoplasmic antibody
aPTT activated partial thromboplastin time
ARB angiotensin receptor blocker
ARDS adult respiratory distress syndrome
AST aspartate aminotransferase
ATP anti-tachycardia pacing
ATP test adenosine triphosphate test
ATV automatic transport ventilator
AVM arteriovenous malformation
AV atrioventricular
AVNRT atrioventricular node reentry tachycardia
AVRT atrioventricular reciprocating tachycardia
BBB bundle branch block
BiPAP bi-level positive airway pressure
BNP B-type natriuretic peptide
BP blood pressure
BUN blood urea nitrogen
CAB circulation, airway and breathing
CABG coronary artery bypass grafting
C1-INH C1-esterase inhibitor
CK-MB creatine kinase MB
CAD coronary artery disease
CBC complete blood count
CCB calcium channel blocker
CCS Canadian Cardiovascular Society
CCU critical care unit
cGMP cyclic guanosine monophosphate
CHF chronic heart failure
CHF congestive heart failure
CKD chronic kidney disease
CMR cardiac magnetic resonsnce
CNS central nervous system
CO_2 carbon dioxide
COPD chronic obstructive pulmonary disease
COX cyclooxygenase
CP chest pain
CPAP continuous positive airway pressure
CPK creatine phosphokinase
CPO cardiogenic pulmonary oedema
CPR cardiopulmonary resuscitation
CRF chronic renal failure
CRT continuous reaction time
CSF cerebrospinal fluid
CT computer tomography
CTI cavotricuspid isthmus
cTn cardiac-specific troponin
CTPA computed tomographic pulmonary angiography
CUS compression ultrasonography
CVA cerebrovascular accident
CVD cardiovascular disease
CVP central venous pressure
CVVHD continuous venovenous haemodiafiltration
CXR chest X-ray
D5W 5 % dextrose in water
DBP diastolic BP
DC cardioversion, DCC direct current cardioversion
DDAVP desamino-D-arginine vasopressin
DIC disseminated intravascular coagulation
DKA diabetic ketoacidosis
DM diabetes mellitus
DSA digital subtraction angiography
DVT deep vein thrombosis
EAR early allergic response

ECG electrocardiogram
ECG electrocardiography
ECMO extracorporeal membrane oxygenator
ED emergency department
EDD esophageal detector device
EEG electroencephalography
EF ejection fraction
EGD esophagogastroduodenoscopy
EMS emergency medical service
EP electrophysiological; electrophysiology
ERCP endoscopic retrograde cholangiopancreatography
ESC European Society of Cardiology
ESWL extracorporeal shockwave lithotripsy
FBAO foreign-body airway obstruction
FBC full blood count
FDA Food and Drug Administration
FEV1 forced expiratory volume in 1 second
FFP fresh frozen plasma
FHF fulminant hepatic failure
GABA gamma-aminobutyric acid
GCS Glasgow coma scale
GERD gastroesophageal reflux
GFR glomerular filtration rate
GI bleeding gastrointestinal bleeding
GpIIb/-IIIa receptor glycoprotein IIb/-IIIa receptor
HAAF hypoglycaemia-associated autonomic failure
HACEK haemophilus actinobacillus cardiobacterium eikenella and kingella
HAE hereditary angioedemoedema
HDU high dependency unit
HE hepatic encephalopathy
H-FABP heart-type fatty acid-binding protein
HFSA Heart Failure Society of America
HIT heparin-induced thrombocytopaenia
HNC hyperosmolar nonketotic coma
HNS hypothalamo-neurohypophysial system
HOCM hypertrophic obstructive cardiomyopathy
HR heart rate
HTN hypertension
IABC intra-aortic balloon catheter
IABP intra-aortic balloon pumping
ICD implantable cardioverter-defibrillator
ICP intracranial pressure
ICU intensive care unit
IgE immunoglobulin E
IGF insulin growth factor
IHD ischaemic heart disease
IHD intermittent haemodialysis
Il iterleukin
IM intramuscular
INR international normalisation ratio
IPC intermittent pneumatic compression
ISDN isosorbide dinitrate
IU international unit
IV intravenous
IVC inferior vena cava
IVP intravenous push
IVP intravenous pyelogram
IVU intravenous urogram
JVD jugulovenous distention
KUB kidney-ureter-bladder
LAD left axis deviation
LAR late allergic response
LBBB left bundle branch block
LGL-syndrome Lown–Ganong–Levine syndrome
LMA laryngeal mask airway
LMWH low-molecular-weight heparin
LOLA L-ornithine L-aspartate
LV left ventricle
LVAD left ventricular assist device
LVEDP left ventricular end-diastolic pressure
LVEF left ventricular ejection fraction
MAT multifocal atrial tachycardia
MCS mechanical circulatory support
MCTPA multidetector CT pulmonary angiography
MDCT multidetector computed tomography
MDRD modification of diet in renal disease
MODS multiple organ dysfunction syndrome
MR mitral regurgitation
MRCP magnetic resonance cholangiopancreatography
MRI magnetic resonance imaging
MRSA methicillin-resistant staphylococcus aureus strains
MS mental status
MTHFR 5,10-methylenetetrahydrofolate reductase

MVP	mitral valve prolapse
MVT	monomorphic ventricular tachycardia
NCPO	non-cardiogenic pulmonary oedema
NIPPV	noninvasive positive pressure ventilation
NIV	noninvasive ventilation
NOAC	new oral anticoagulant
NSAIDs	non-steroidal anti-inflammatory drugs
NST-ACS	non-ST-segment elevation acute coronary syndrome
NSTEMI	non-ST-segment elevation myocardial infarction
NTG	nitroglycerin
OD	overdose
$PaCO_2$	partial pressure of carbon dioxide in arterial blood
PAD	peripheral artery disease
PaO_2 or PO_2	partial pressure of oxygen
PCI	percutaneous coronary intervention
PCNL	percutaneous nephrolithotomy
PCT	procalcitonin
PCWP	pulmonary capillary wedge pressure
PD	peritoneal dialysis
PE	peritoneal dialysys
PE	pulmonary embolism
PEEP	positive end-expiratory pressure
PEFR	peak expiratory flow rate
PEG	polyethylene glycol
PIOPED	prospective investigation of pulmonary embolism diagnosis
PMI	point of maximal impulse
po or p.o.	per os
PO	partial pressure of oxygen
PO	pulmonary oedema
PPI	proton pump inhibitor
prn	when necessary
PSE	portosystemic encephalopathy
PSS	partosystemic shunt
PSVT	paroxysmal supraventricular tachycardia
PTBR	peripheral-type benzodiazepine receptor
PTCA	percutaneous transluminal coronary angioplasty
PVT	polymorphic ventricular tachycardia
RAAS	renin-angiotensin-aldosterone system
RAD	right axis deviation
RAST	radioallergosorbent assay
RBBB	right bundle branch block
RMSF	Rocky mountain spotted fever
ROSC	return of spontaneous circulation
RRT	renal replacement therapy
RV	right ventricle
RVOT	right ventricular outflow tract
SA	sinoatrial
SBP	systolic blood pressure
SCD	sequential compression device
SCD	sudden cardiac death
SIRS	systemic inflammatory response syndrome
SLE	systemic lupus erythematosus
SOB	shortness of breath
SRS-A	slow-release substance-anaphylaxis
STEMI	ST-segment elevation myocardial infarction
SVT	supraventricular tachycardia
TB	tuberculosis
TBI	traumatic brain injury
TIA	transient ischaemic attack
TIMI	thrombolysis in myocardial infarction
TIPS	transjugular intrahepatic portosystemic shunt
TNF	tumour necrosis factor
TnI	troponin I
TnT	troponin T
TOD	target organ damage
TOE	transoesophageal echo
TSH	thyroid-secreting hormone
TTP	thrombocytopenic purpura
UA	unstable angina
UA	urinalysis
UO	urine output
UFH	unfractionated heparin
V/Q scan	ventilation/perfusion scan
VC	vomiting centre
VF	ventricular fibrillation
VKA	vitamin K antagonist
VPB	ventricular premature beats
VSR	ventricular septal rupture
VT	ventricular tachycardia
VVS	vasovagal syncope
WBC	white blood cell count
WPW	Wolff–Parkinson–White syndrome

Chapter 1

CARDIOPULMONARY RESUSCITATION

Definition

Cardiac arrest is a sudden cessation of effective cardiac pumping function as a result of either ventricular asystole (electrical or mechanical) or pulseless ventricular tachycardia or ventricular fibrillation. Cardiac arrest manifests clinically as sudden cardiac death. **Sudden cardiac death** is unexpected natural death from a cardiac cause within one hour of the onset of symptoms in a person without a previous condition that would appear fatal.

Epidemiology

Sudden cardiac death is a major clinical problem causing 300,000 to 400,000 deaths annually. The reported incidence of sudden cardiac death is 54 to 55 per 100,000 persons, accounting for 5.6 % of annual mortality. It was reported that 63 % of all cardiac deaths were caused by sudden cardiac death. Despite the overall decrease in cardiovascular mortality, the proportion of sudden cardiac death has remained constant.

Etiology and Pathogenesis

Cardiac arrest is strongly associated with coronary artery disease. This disease is present in 50 % to 80 % of patients older than 35 years of age with sudden cardiac death, either by history or autopsy. Weaver and colleagues demonstrated an 81 % prevalence of coronary artery disease on coronary angiography in CPR survivors. Other diseases associated with sudden cardiac death include aortic stenosis, congenital heart disease, Wolff–Parkinson–White syndrome and cardiomyopathies. The incidence of ventricular tachycardia or ventricular fibrillation presenting as cardiac arrest has been declining — only 21 % to 32 % of cardiac arrests present as ventricular tachycardia or ventricular fibrillation. Asystole and pulseless electrical activity are presenting more commonly as initial rhythms.

Coronary artery disease and cardiomyopathies account for 90 % to 95 % of cases of sudden cardiac death in the United States. Both diseases

act as structural substrates underlying the functional abnormality of arrhythmias. Therefore, underlying risk factors for coronary artery disease act as risk factors for sudden cardiac death over time. Transient risk factors, such as myocardial ischaemia, hypoxaemia, acidosis, electrolyte imbalances and toxic effects of certain drugs act on the underlying structural abnormalities to produce ventricular tachycardia or ventricular fibrillation.

As time passes, ventricular tachycardia or ventricular fibrillation deteriorates to asystole, which has a dismal prognosis. Patients with ventricular tachycardia or ventricular fibrillation are more responsive to resuscitative efforts than are those with asystole or pulseless electrical activity. Weisfeldt and Becker proposed a 3-phase time-sensitive model of cardiac arrest. These phases are the electrical, circulatory and metabolic phases, lasting 0 to 4 minutes, 4 to 10 minutes and more than 10 minutes, respectively, from the time of cardiac arrest. Each requires specific treatments. During the electrical phase of cardiac arrest, defibrillation is the most effective treatment, whereas in the circulatory phase, good-quality CPR gains increasing importance, along with defibrillation. In the third and finalmetabolic phase, global ischaemic injury occurs and therapeutic strategies that focus on metabolic derangements are critical.

Survival rates among patients in out-of-hospital cardiac arrest vary from 5 % to 18 %. Survival also depends on the presenting rhythm, with a low 0.9 % survival rate for pulseless electrical activity and asystole and a 9.5 % to 41 % reported survival rate for ventricular tachycardia or ventricular fibrillation.

Clinical Presentation

Early recognition is a key step in the early treatment of cardiac arrest. It is important to determine the most accurate method of diagnosing cardiac arrest.

Rescuers should start CPR if the victim is unconscious (unresponsive), not moving and not breathing. Even if the victim takes occasional gasps, rescuers should suspect that cardiac arrest has occurred and should start CPR. The rescuer should not spend more than 10 seconds checking for a pulse, and if a pulse is not definitely felt within 10 seconds, should begin CPR and use AEDs when available.

Early CPR and Defibrillation

Cardiopulmonary resuscitation provides artificial circulation and ventilation until advanced life support can be provided and spontaneous circulation and ventilation can be restored.

The 2010 AHA Guidelines for CPR and ECC recommend a change in the basic life support a sequence of steps from A-B-C (Airway, Breathing, Chest compressions) to C-A-B (Chest compressions, Airway, Breathing) for adults, children and infants (excluding the newly born).

CPR is divided into three support stages:

Basic life support:

- **C — C**irculation support.
- **A — A**irway.
- **B — B**reathing support.

Advanced life support:

- **D — D**iagnosis and **D**rugs.
- **E — E**lectrocardiography.
- **F — F**ibrillation control

Prolonged life support:

- **G — G**auging the patient's response.
- **H — H**opeful measures for the brain.
- **I — I**ntensive care.

Basic Life Support

Initial steps of resuscitation may include:

1. The lone rescuer should begin CPR with 30 compressions.
2. Opening the airway.
3. Giving 2 breaths.

Chest Compressions. Several components of chest compressions can alter effectiveness: hand position, position of the rescuer, position of the victim, depth and rate of compression, decompression and duty cycle. Evidence for these techniques was reviewed in an attempt to define the optimal method.

Chest Compression Technique. It is reasonable for laypeople and healthcare professionals to be taught to position the heel of their dominant hand in the centre of the chest of an adult victim, with the nondominant hand on top.

It is reasonable for lay rescuers and healthcare providers to perform chest compressions for adults at a rate of at least 100 compressions per min and to compress the sternum by at least 5 cm. Rescuers should allow complete recoil of the chest after each compression. When feasible, rescuers should frequently alternate the "compressor" duties, regardless of whether they feel fatigued, to ensure that fatigue does not interfere with the delivery of adequate chest compressions. It is reasonable to use a duty cycle (i. e. the ratio between compression and release) of 50 %.