ACVC
Association for
Acute CardioVascular Care

Edition 2025

CLINICAL DECISION MAKING TOOLKIT

Instant guidance for diagnosis, risk stratification and management

ESC
European Society
of Cardiology

The Clinical Decision Making Toolkit

is produced by the Association for Acute CardioVascular Care (ACVC) of the European Society of Cardiology (ESC).

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Clinical Decision-Making TOOLKIT

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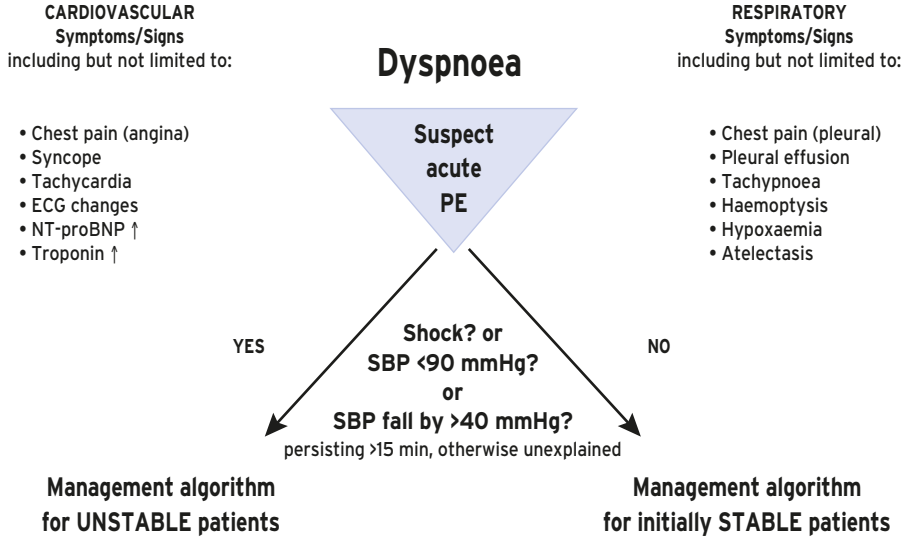
ACUTE PULMONARY EMBOLISM

Ingo Ahrens, Erik Klok, Stavros V Konstantinides, Umit Yasar Sinan

ACUTE PULMONARY EMBOLISM: Diagnosis



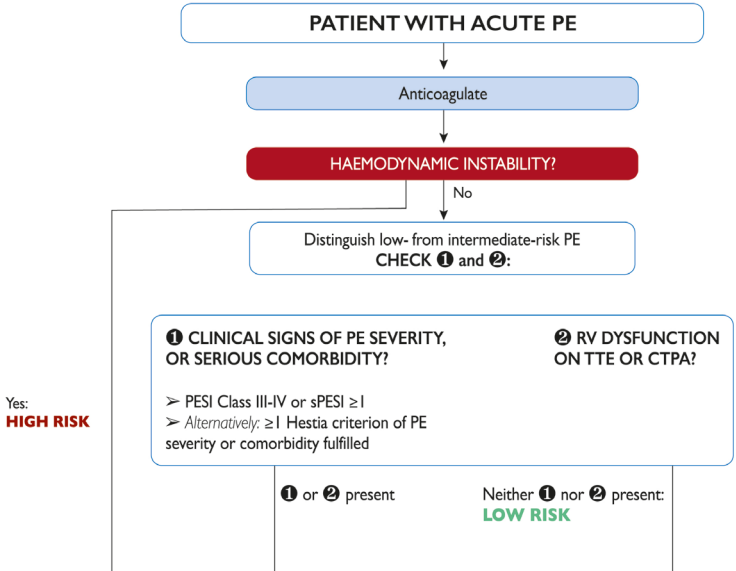
IACC Texbook (2021) Chapter 63 Pulmonary Embollism page851 - figure 63.1

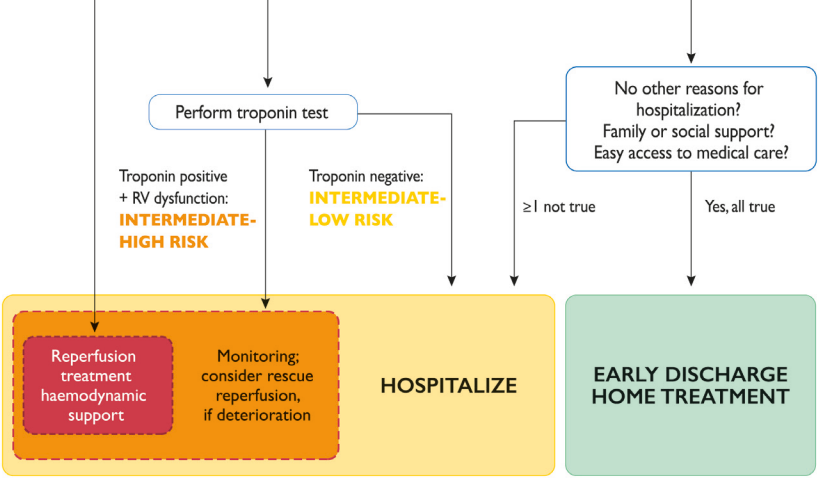
ACUTE PULMONARY EMBOLISM
Criteria for high-risk

(1) Cardiac arrest	(2) Obstructive shock	(3) Persistent hypotension
Need for cardiopulmonary resuscitation	Systolic BP <90 mmHg, or vasopressors required to achieve a BP ≥90 mmHg despite adequate filling status and End-organ hypoperfusion (altered mental status; cold, clammy skin; oliguria/ anuria; increased serum lactate)	Systolic BP <90 mmHg, or systolic BP drop ≥40 mmHg, either lasting longer than 15 minutes or not caused by new-onset arrhythmia, hypovolaemia, or sepsis
and RV dysfunction (TTE or CTPA)		
At least one of the clinical manifestations indicate high-risk PE. BP: blood pressure; CTPA: computed tomography pulmonary angiography; RV: right ventricular; TTE: transthoracic echocardiography		

Percutaneous Treatment Options for Acute Pulmonary Embolism EuroIntervention 18, no. 8 (2023): e623–e638, Table 1

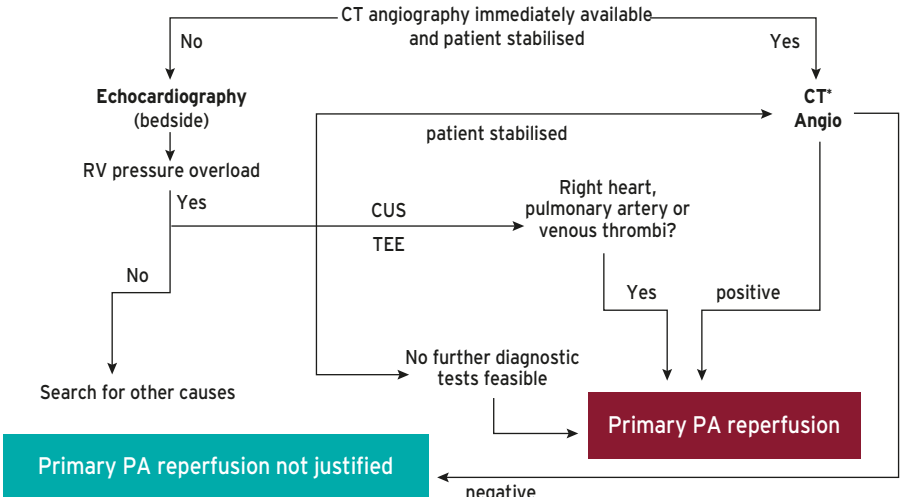
ACUTE PULMONARY EMBOLISM
Risk-adjusted management strategies for all patients, irrespectively of risk





2019 ESC Guidelines for the diagnosis and management of acute pulmonary embolisms European Heart Journal, Volume 41, Issue 4, 21 January 2020, Pages 543–603 Figure 6

Management algorithm for unstable patients with suspected ACUTE PULMONARY EMBOLISM



* Consider also pulmonary angiography if unstable patient in catheterization lab.

ACUTE PULMONARY EMBOLISM
Management strategy for initially unstable patients with confirmed high-risk features

Shock or hypotension	**YES**		
Contraindications to thrombolysis	None	Relative	Absolute
Primary PA reperfusion strategy	**Systemic (intravenous) thrombolysis**	**Catheter-directed treatment (mechanical thrombectomy or thrombolysis), or surgical embolectomy or systemic thrombolysis if other options are not available.**	**Catheter-directed treatment (mechanical thrombectomy) or surgical embolectomy**
Supportive treatment	**i.v. UFH, stabilise systemic blood presssure, correct hypoxaemia**		

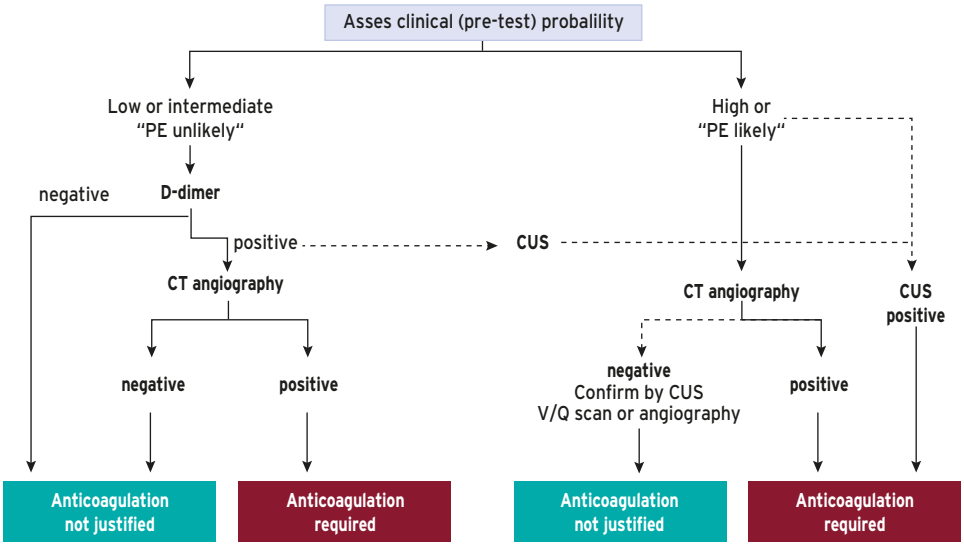
Contraindications to fibrinolysis in high-risk PE

Absolute	Relative
– History of haemorrhagic stroke or stroke of unknown origin – Ischaemic stroke in previous 6 months – Central nervous system neoplasm – Major trauma, surgery, or head injury in previous 3 weeks – Bleeding diathesis – Active bleeding	– Transient ischaemic attack in previous 6 months – Oral anticoagulation – Pregnancy or first postpartum week – Non-compressible puncture sites – Traumatic resuscitation – Use of ECMO – Advanced liver disease – Infective endocarditis – Active peptic ulcer – Refractory hypertension (systolic BP >180 mmHg)

BP: blood pressure; ECMO: extracorporeal membrane oxygenation; PE: pulmonary embolism

Percutaneous Treatment Options for Acute Pulmonary Embolism EuroIntervention 18, no. 8 (2023): e623-e638, Table 3

Management algorithm for initially stable patients with suspected ACUTE PULMONARY EMBOLISM



Suggested management strategy for initially stable patients with (non-high risk) confirmed ACUTE PULMONARY EMBOLISM

Markers for myocardial injury	Positive	Positive	Negative
Markers for RV overload	Positive	Positive	Negative
Clinical risk assessment score (PESI)	Positive (class III-V)	Positive (class III-V)	Negative (class I-II)
Suggested initial anticoagulation	UFH i.v./LMWH s.c.	LMWH/Fonda/apixaban/ rivaroxaban	apixaban/rivaroxaban
STRATEGY	**Monitoring (ICU)* rescue thrombolysis**	**Hospitalisation** (telemonitoring)**	**Early discharge*****

* When all markers are positive. - ** When at least one marker is positive. - *** When all markers are negative.

For more information on individual drug doses and indications,
SEE CHAPTER 9 **DRUGS USED IN ACUTE CARDIOVASCULAR CARE**

HESTIA exclusion criteria for outpatient management

Criterion/question
Is the patient haemodynamically unstable?[a]
Is thrombolysis or embolectomy necessary?
Active bleeding or high risk of bleeding?[b]
More than 24 h of oxygen supply to maintain oxygen saturation >90%?
Is PE diagnosed during anticoagulant treatment?
Severe pain needing i.v. pain medication for more than 24 h?
Medical or social reason for treatment in the hospital for >24 h (infection, malignancy, or no support system)?
Does the patient have a CrCl of <30 mL/min?[c]
Does the patient have severe liver impairment?[d]
Is the patient pregnant?
Does the patient have a documented history of heparin-induced thrombocytopenia?

Hestia exclusion criteria for outpatient management of pulmonary embolism (from Zondag *et al.*[32]). If the answer to one or more of the questions is 'yes', then the patient cannot be treated at home.
BP = blood pressure; b.p.m. = beats per minute; CrCl = creatinine clearance; i.v. = intravenous; PE = pulmonary embolism.
[a]Include the following criteria but leave them to the discretion of the investigator: systolic BP <100 mmHg with heart rate >100 b.p.m.; condition requiring admission to an intensive care unit.
[b]Gastrointestinal bleeding in the preceding 14 days, recent stroke (<4 weeks ago), recent operation (<2 weeks ago), bleeding disorder or thrombocytopenia (platelet count $<75 \times 10^9$/L), or uncontrolled hypertension (systolic BP >180 mmHg or diastolic BP >110 mmHg).
[c]Calculated CrCl according to the Cockroft–Gault formula.
[d]Left to the discretion of the physician.

2019 ESC Guidelines for the diagnosis and management of acute pulmonary embolisms European Heart Journal, Volume 41, Issue 4, 21 January 2020, Pages 543–603 - Supplementary Table 12

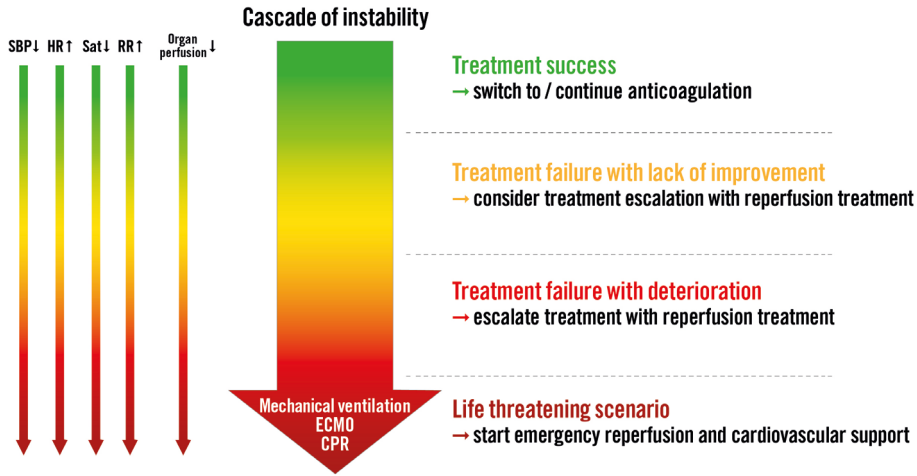
ACUTE PULMONARY EMBOLISM
Pharmacological treatment

Key drugs for initial treatment of patients

Unstable	Alteplase (rtPA) (intravenous)	100 mg/2h or 0.6 mg/kg/15 min (max 50 mg)
	Urokinase (intravenous)	3 million IU over 2h
	Streptokinase (intravenous)	1.5 million IU over 2h
	Unfractionated heparin (intravenous)	80 IU/kg bolus + 18 IU/kg/h
Stable	Enoxaparine (subcutaneous)	1 mg/kg BID or 1.5 mg/kg QD
	Tinzaparin (subcutaneous)	175 U/kg QD
	Fondaparinux (subcutaneous)	7.5 mg (50-100 kg of body weight) 5 mg for patients <50 kg, 10 mg for patients >100 kg
	Rivaroxaban (oral)	15 mg BID (for 3 weeks, then 20 mg QD)
	Apixaban (oral)	10 mg bid (for 7 days, than 5 mg bid)
	Dabigatran (oral	Parenteral anticoagulant for ≥5 days followed by dabigatran 150 mg b.i.d.
	Edoxaban (oral):	Enoxaparin or UFH for ≥5 days followed by edoxaban (60 mg o.d.; 30 mg o.d. if CrCl 30-50 mL/min or body weight <60 kg)

For more information on individual drug doses and indications,
SEE CHAPTER 9 **DRUGS USED IN ACUTE CARDIOVASCULAR CARE**

ACUTE PULMONARY EMBOLISM
Treatment efficacy and clinical deterioration



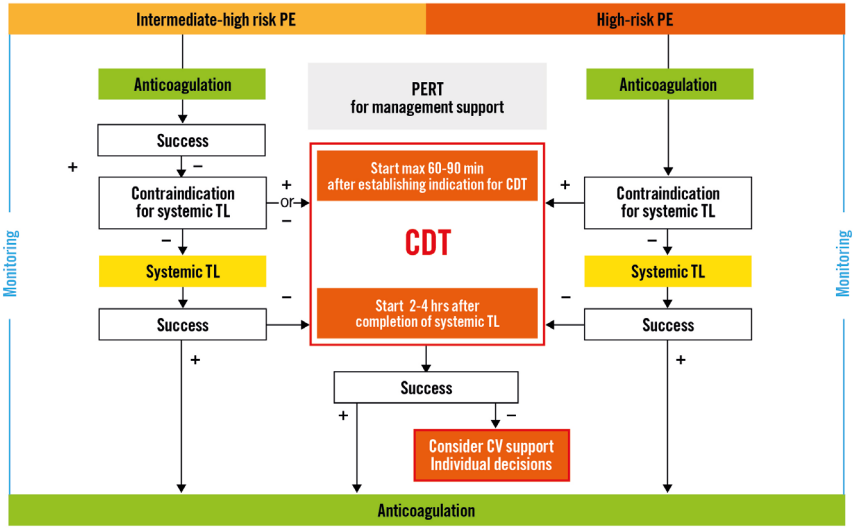
Percutaneous Treatment Options for Acute Pulmonary Embolism EuroIntervention 18, no. 8 (2023): e623-e638, figure 1

ACUTE PULMONARY EMBOLISM
Current indications for catheter-directed treatment

High-risk PE	Intermediate-high risk PE
As first-line treatment in the presence of contraindication(s) to systemic thrombolysis or As escalating/rescue treatment if systemic thrombolysis fails	As escalating/rescue treatment for haemodynamic deterioration despite adequate anticoagulation, in the presence of contraindication(s) to systemic thrombolysis or As escalating/rescue treatment for haemodynamic deterioration despite adequate anticoagulation, if systemic thrombolysis fails

Percutaneous Treatment Options for Acute Pulmonary Embolism EuroIntervention 18, no. 8 (2023): e623–e638, table 4

Central role of multidisciplinary treatment of severe ACUTE PULMONARY EMBOLISM



Percutaneous Treatment Options for Acute Pulmonary Embolism EuroIntervention 18, no. 8 (2023): e623-e638, central illustration

Abbreviations

APTT = Activated partial thromboplastin time
AB = Airway and breathing
ABG = Arterial blood gas
AADs = Antiarrhythmic drugs
AAS = Acute aortic syndrome
ACEI = Angiotensin converting enzyme inhibitor
ACLS = Advanced cardiovascular life support
ACS = Acute coronary syndrome
ACT = Activated clotting time
AD = Aortic Dissection
AED = Automated external defibrillator
AF = Atrial fibrillation
ANA = Antinuclear antibodies
Ao = Aortic
aPTT = Activated partial thromboplastin time
ARB = Angiotensin receptor blockers
AS = Aortic stenosis
AV = Atrioventricular
AVB = Atrioventricular conduction block
AVN = Atrioventricular node
AVNRT = Atrioventricular nodal re-entrant tachycardia
AVNT = Atrioventricular nodal tachycardia
BID = Twice a day
BBB = Bundle branch block
BLS = Basic life support
BNP = Brain natriuretic peptide
BP = Blood pressure
CABG = Coronary artery bypass grafting
CAD = Coronary artery disease
Cath Lab = Catheterisation laboratory
CCB = Calcium channel blockers
CCU = Coronary care unit
CHF = Congestive heart failure
CMR = Cardiovascular magnetic resonance
COPD = Chronic obstructive pulmonary disease
CPAP = Continuous positive airway pressure
CPR = Cardiopulmonary resuscitation
Cr = Creatinine blood level (mg/dL)
CrCl = Creatinine clearance
CRP = C-reactive protein
CS = Cardiogenic shock
CSM = Carotid sinus massage
CSNRT = Corrected sinus node recovery time

Abbreviations (Cont.)

CSS = Carotid sinus syndrome
CT = Computed tomography
CT-angio = Computed tomography angiography
cTn = Cardiac troponin
CUS = Compression venous ultrasound
CV = Cardiovascular
CVA = Cerebrovascular accident
CXR = Chest X-ray
DAPT = Dual antiplatelet therapy
DD = Dyastolic dysfunction
DM = Diabetes mellitus
dTT = Diluted thrombin time
DVT = Deep vein thrombosis
ECG = Electrocardiogram
Echo = Echocardiogram
ECMO = Extracorporeal membrane oxygenation
ECT = Ecarin clotting time
ED = Emergency department
EF = Ejection fraction
EG = Electrograms
eGFR = Estimated glomerular filtration rate (ml/min/1.73 m^2)
EMB = Endomyocardial biopsy
EMS = Emergency medical services
EPS = Electrophysiological study
ERC = European Resuscitation Council
ESR = Erythrocyte sedimentation rate
ETT = Exercice treadmill testing
FFP = Fresh frozen plasma
FMC = First medical contact
GER = Gastroesophageal reflux
GFR = Glomerular flow rate
GI = Gastrointestinal
GP = Glycoprotein
Hb = Haemoglobin
HF = Heart failure
HIT = Heparin-induced thrombocytopenia
HOCM = Hypertrophic obstructive cardiomyopathy
HTN = Hypertension
HR = Heart rate
hsTn = High-sensitive troponin
IABP = Intra-aortic balloon pump
ICC = Intensive cardiac care
ICCU = Intensive cardiac care unit

Abbreviations (Cont.)

ICD = Implantable cardioverter defibrillator
ICI = Immune checkpoint inhibitors
IHD = Ischemic heart disease
IMH = Intramural hematoma
IRF = Immediate-release formulation
ISFC = International Society and Federation of Cardiology
i.o. = Intraosseous
IV = Invasive ventilation
i.v. = Intravenous
KD = Kidney disease
LBBB = Left bundle branch block
LD = Loading dose
LGE = Late gadolinium enhancement
LMWH = Low-molecular weight heparin
LOC = Loss of consciousness
LV = Left ventricular
LVAD/Bi-AD = left ventricular, bi-ventricular assist device
LVD = Left ventricular dysfunction
LVEF = Left ventricular ejection fraction
LVH = Left ventricular hypertrophy
LVSD = Left ventricular systolic dysfunction
MCS = Mechanical circulatory support
MD = Maintenance dose
MDCT = Computed tomography with >4 elements
MI = Myocardial infarction
MRA = Mineralocorticoid receptor antagonist
MRI = Magnetic resonance imaging
Mvo = Microvascular obstruction
NIV = Non-invasive ventilation
NOAC = New oral anticoagulants
NSAID = Non-steroidal anti-inflammatory drugs
NSVT = Non-sustained ventricular tachycardia or recurrent
NSTE-ACS = Non ST-segment elevation acute coronary syndrome
NSTEMI = Non ST-segment elevation myocardial infarction
NTG = Nitroglycerin
NT-proBNP = N-terminal pro brain natriuretic peptide
NVAF = Non-valvular atrial fibrillation
NYHA = New York Heart Association

Abbreviations (Cont.)

OH = Orthostatic hypotension
PAP = Pulmonary arterial pressure
PAU = Penetrating aortic ulcer
PCI = Percutaneous coronary intervention
PCM = Physical counter-measures
PCP = Pulmonary capillary pressure
PE = Pulmonary embolism
PEA = Pulmonary endarterectomy
PEEP = Positive end expiratory pressure
PPC = Prothrombin complex concentrate
PR = Pulmonary regurgitation
PRECISE-DAPT = PREdicting bleeding Complications In patients undergoing Stent implantation and subsEquent Dual Anti Platelet Therapy
PRF = Prolonged-release formulation
ProCT = Procalcitonin
PRN = Pro re nata
PS-PEEP = Pressure support-positive end-expiratory pressure
PSVT = Paroxysmal supraventricular tachycardia
QD = Once a day
QPM = Every evening
rFVIIa = Recombinant factor VIIa
rtPA = Recombinant tissue plasminogen activator
RV = Right ventricular
RVOT-VT = Right ventricular outflow tract ventricular tachycardia
SBP = Systemic blood pressure
s.c = Subcutaneous
SIRS = Systemic inflammatory response syndrome
SLE = Systemic lupus erythematosus
SMU = Syncope management units
STE-ACS = ST-segment elevation acute coronary syndrome
STEMI = ST-segment elevation myocardial infarction
SVT = Supraventricular tachycardia
Spo_2 = Oxygen saturation
TEE = Transesophageal echocardiography
TEVAR = Thoracic endovascular aortic repair
TIA = Transient ischemic attack
TID = Three times a day
TLOC = Transient loss of consciousness
TOE = Transoesopageal echocardiography

Abbreviations (Cont.)

TSH = Thyroid-stimulating hormone
TTE = Transthoracic echocardiography
UA = Unstable angina
UFH = Unfractionated heparin
ULN = Upper limit of normal
VBGA = venous blood gas analysis
VF = Ventricular fibrillation
VR = Vascular resistance
VT = Ventricular tachycardia
VTE = Venous thromboembolism
VVS = Vasovagal syncope
WBC = white blood cell count
WHO = World Health Organization
WPW = Wolff-Parkinson-White

References and copyright acknowledgments

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