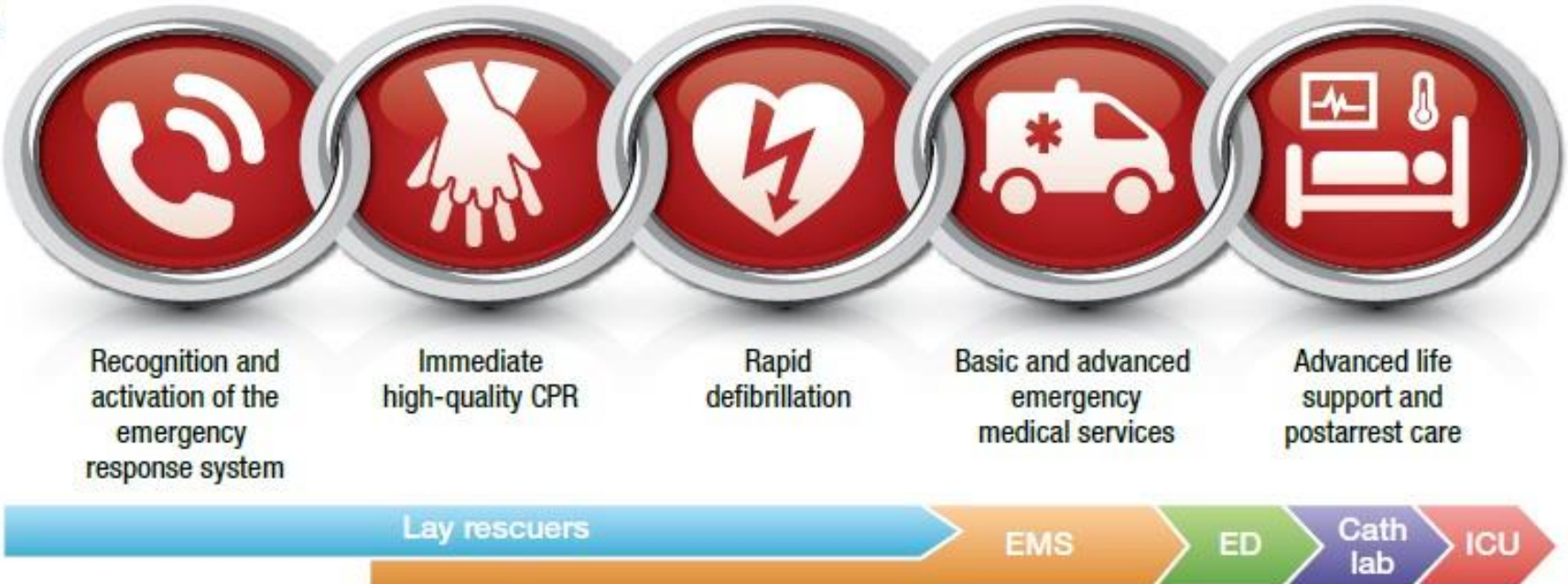
*ACLS

นพ.ชวิน รักษ์รัชตกุล

IHCA


Surveillance and prevention
Recognition and activation of the emergency response system
Immediate high-quality CPR
Rapid defibrillation
Advanced life support and postarrest care
Primary providers
Code team
Cath lab
ICU

OHCA

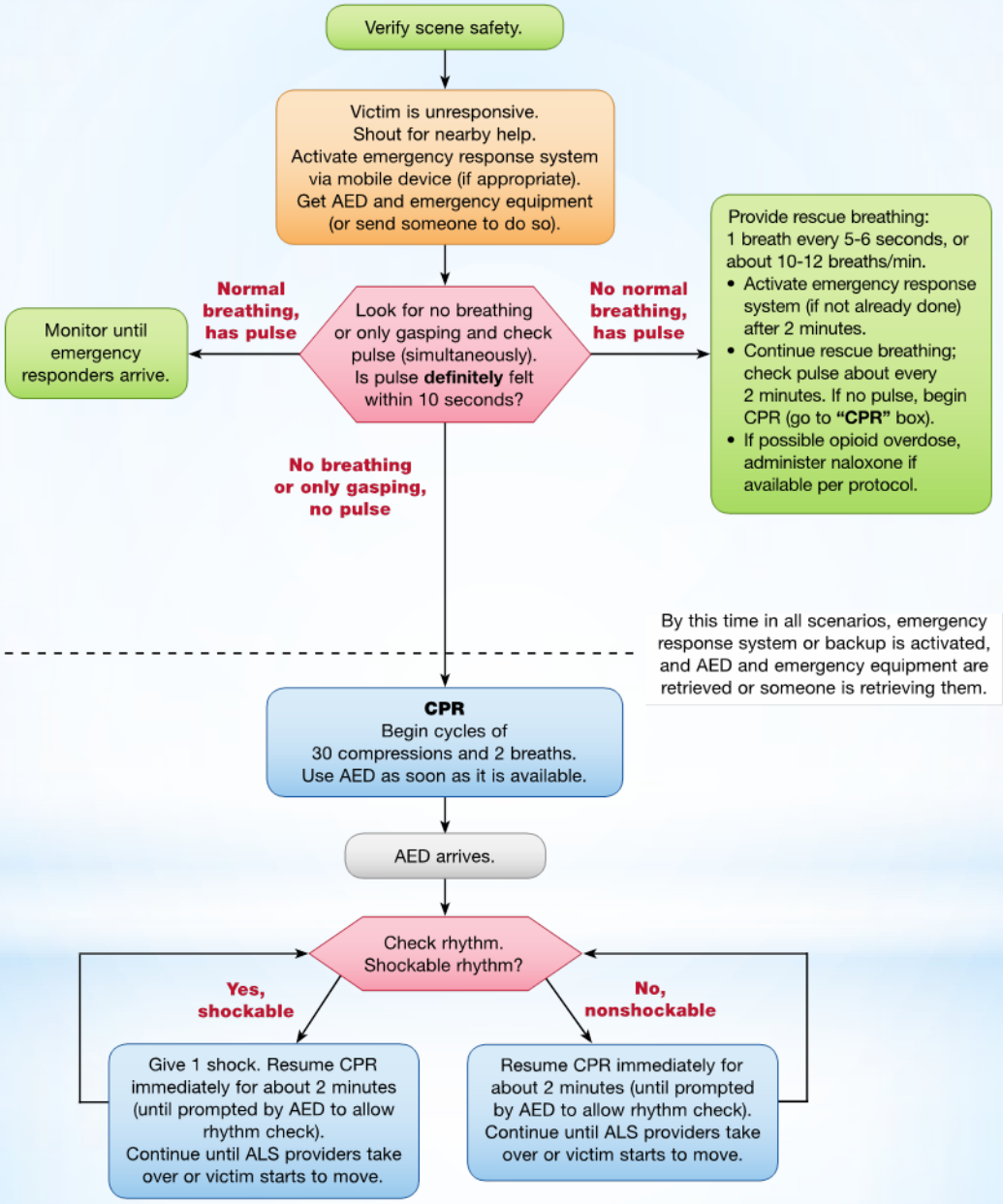

Recognition and activation of the emergency response system
Immediate high-quality CPR
Rapid defibrillation
Basic and advanced emergency medical services
Advanced life support and postarrest care
Lay rescuers
EMS
ED
Cath lab
ICU

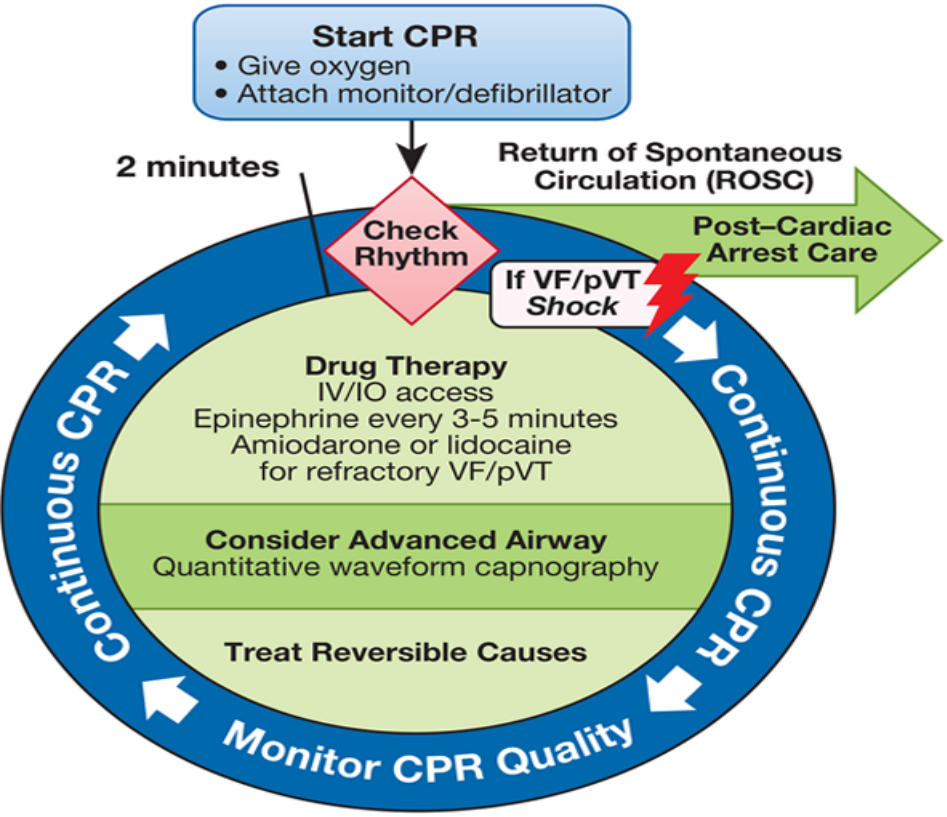
ผู้ช่วยเหลือควร	ผู้ช่วยเหลือ *ไม่ควร*
ดำเนินการกดหน้าอกที่อัตราเร็ว 100–120 ครั้ง/นาที	กดที่อัตราเร็วที่ช้ากว่า 100 ครั้ง/นาที หรือเร็วกว่า 120 ครั้ง/นาที
กดที่ความลึกอย่างน้อยที่สุด 2 นิ้ว (5 เซนติเมตร)	กดที่ความลึกน้อยกว่า 2 นิ้ว (5 เซนติเมตร) หรือมากกว่า 2.4 นิ้ว (6 เซนติเมตร)
ปล่อยให้หน้าอกขยายกลับได้เต็มที่หลังจากการกดแต่ละครั้ง	พิงบนหน้าอกระหว่างการกด
เว้นระยะในการกดให้น้อยที่สุด	เว้นระยะการกดเป็นเวลามากกว่า 10 วินาที
ช่วยหายใจอย่างเพียงพอ (ผายปอด 2 ครั้งหลังการกด 30 ครั้ง การผายปอดแต่ละครั้งมากกว่า 1 วินาทีและสามารถทำให้หน้าอกยกตัวขึ้นได้ในแต่ละครั้ง)	ช่วยหายใจมากเกินไป (เช่น การผายปอดบ่อยครั้งเกินไปหรือการผายปอดด้วยแรงที่มากเกินไป)

Component	Adults and Adolescents	Children (Age 1 Year to Puberty)	Infants (Age Less Than 1 Year, Excluding Newborns)
Scene safety	Make sure the environment is safe for rescuers and victim		
Recognition of cardiac arrest	Check for responsiveness No breathing or only gasping (ie, no normal breathing) No definite pulse felt within 10 seconds (Breathing and pulse check can be performed simultaneously in less than 10 seconds)		
Activation of emergency response system	If you are alone with no mobile phone, leave the victim to activate the emergency response system and get the AED before beginning CPR Otherwise, send someone and begin CPR immediately; use the AED as soon as it is available	***Witnessed collapse*** Follow steps for adults and adolescents on the left ***Unwitnessed collapse*** Give 2 minutes of CPR Leave the victim to activate the emergency response system and get the AED Return to the child or infant and resume CPR; use the AED as soon as it is available	
Compression-ventilation ratio *without advanced airway*	***1 or 2 rescuers*** 30:2	***1 rescuer*** 30:2 ***2 or more rescuers*** 15:2	

Component	Adults and Adolescents	Children (Age 1 Year to Puberty)	Infants (Age Less Than 1 Year, Excluding Newborns)
Compression-ventilation ratio *with advanced airway*	Continuous compressions at a rate of 100-120/min Give 1 breath every 6 seconds (10 breaths/min)		
Compression rate	100-120/min		
Compression depth	At least 2 inches (5 cm)*	At least one third AP diameter of chest About 2 inches (5 cm)	At least one third AP diameter of chest About 1½ inches (4 cm)
Hand placement	2 hands on the lower half of the breastbone (sternum)	2 hands or 1 hand (optional for very small child) on the lower half of the breastbone (sternum)	***1 rescuer*** 2 fingers in the center of the chest, just below the nipple line ***2 or more rescuers*** 2 thumb–encircling hands in the center of the chest, just below the nipple line
Chest recoil	Allow full recoil of chest after each compression; do not lean on the chest after each compression		
Minimizing interruptions	Limit interruptions in chest compressions to less than 10 seconds		

BLS Healthcare Provider
Adult Cardiac Arrest Algorithm—2015 Update





CPR Quality

- Push hard (at least 2 inches [5 cm]) and fast (100-120/min) and allow complete chest recoil.
- Minimize interruptions in compressions.
- Avoid excessive ventilation.
- Change compressor every 2 minutes, or sooner if fatigued.
- If no advanced airway, 30:2 compression-ventilation ratio.
- Quantitative waveform capnography
  - If P_{ETCO_2} <10 mm Hg, attempt to improve CPR quality.
- Intra-arterial pressure
  - If relaxation phase (diastolic) pressure <20 mm Hg, attempt to improve CPR quality.

Shock Energy for Defibrillation

- **Biphasic:** Manufacturer recommendation (eg, initial dose of 120-200 J); if unknown, use maximum available. Second and subsequent doses should be equivalent, and higher doses may be considered.
- **Monophasic:** 360 J

Drug Therapy

- **Epinephrine IV/IO dose:** 1 mg every 3-5 minutes
- **Amiodarone IV/IO dose:** First dose: 300 mg bolus. Second dose: 150 mg.

-OR-

Lidocaine IV/IO dose: First dose: 1-1.5 mg/kg. Second dose: 0.5-0.75 mg/kg.

Advanced Airway

- Endotracheal intubation or supraglottic advanced airway
- Waveform capnography or capnometry to confirm and monitor ET tube placement
- Once advanced airway in place, give 1 breath every 6 seconds (10 breaths/min) with continuous chest compressions

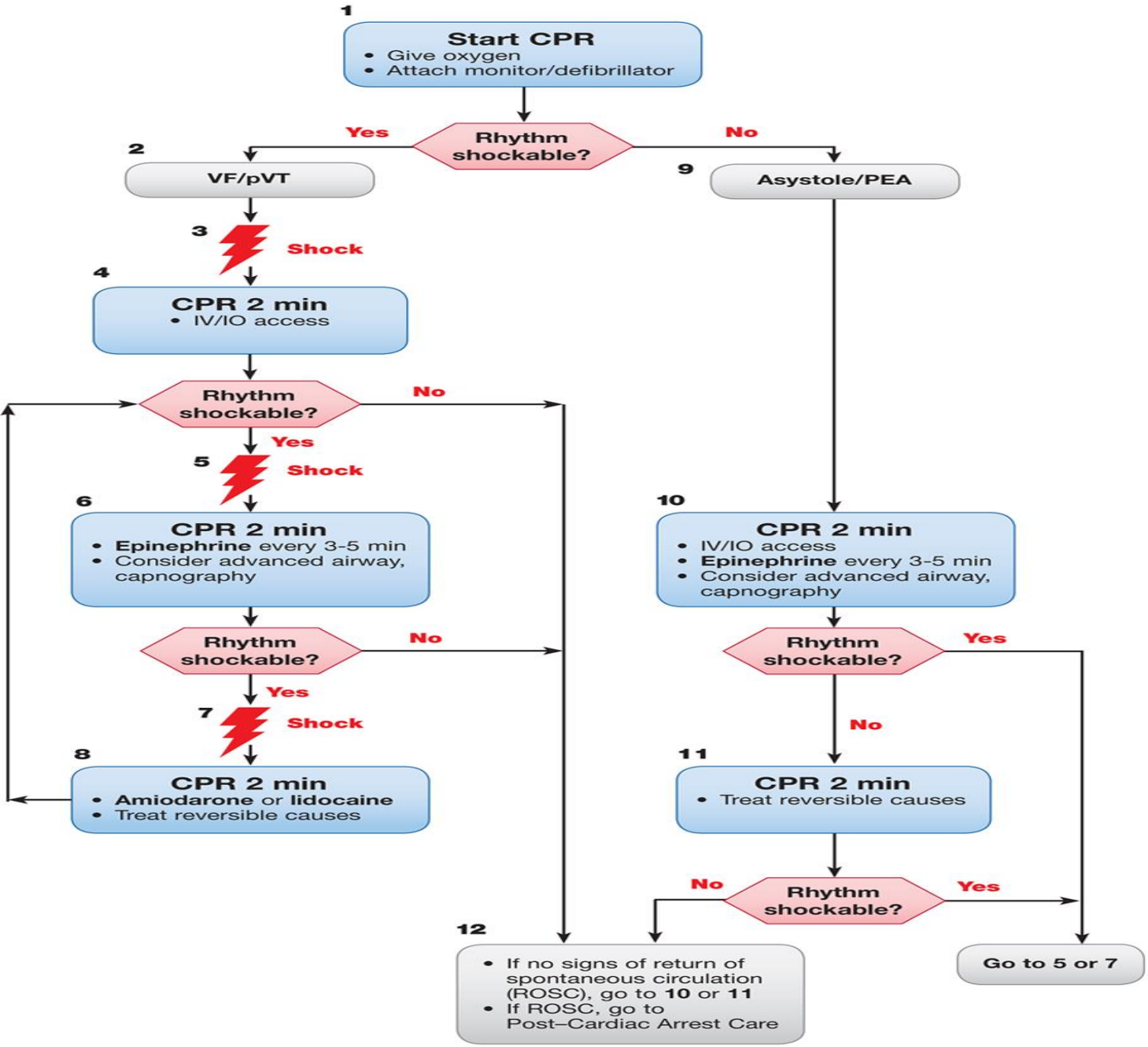
Return of Spontaneous Circulation (ROSC)

- Pulse and blood pressure
- Abrupt sustained increase in P_{ETCO_2} (typically ≥40 mm Hg)
- Spontaneous arterial pressure waves with intra-arterial monitoring

Reversible Causes

- **H**ypovolemia
- **H**ypoxia
- **H**ydrogen ion (acidosis)
- **H**ypo-/hyperkalemia
- **H**ypothermia
- **T**ension pneumothorax
- **T**amponade, cardiac
- **T**oxins
- **T**hrombosis, pulmonary
- **T**hrombosis, coronary

2018 American Heart Association Focused Update on Advanced Cardiovascular Life Support Use of Antiarrhythmic Drugs During and Immediately After Cardiac Arrest: An Update to the American Heart Association Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care, Volume: 138, Issue: 23, Pages: e740-e749, DOI: (10.1161/CIR.0000000000000613)



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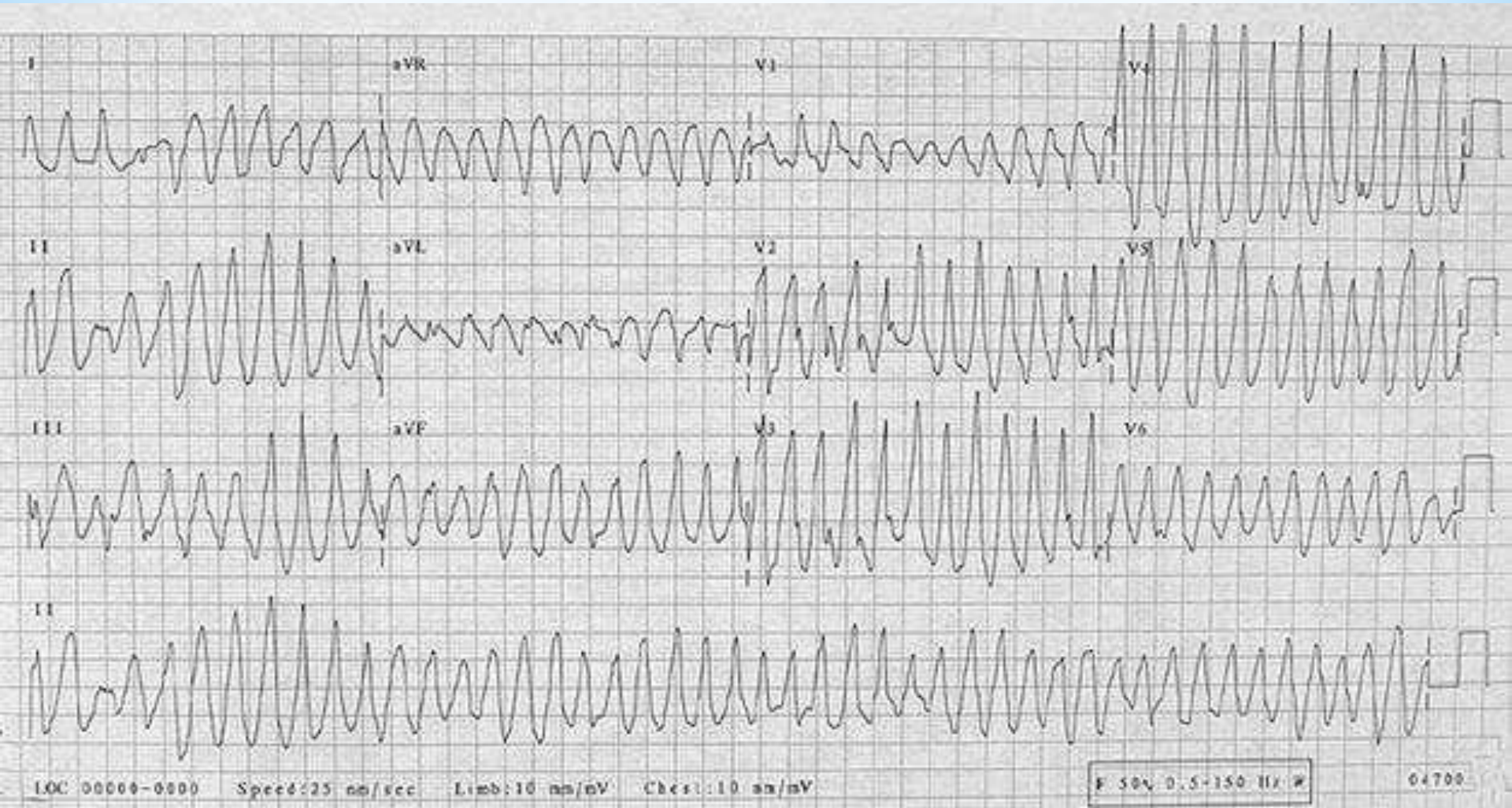
*Treatable Causes of Cardiac Arrest: The H's and T's

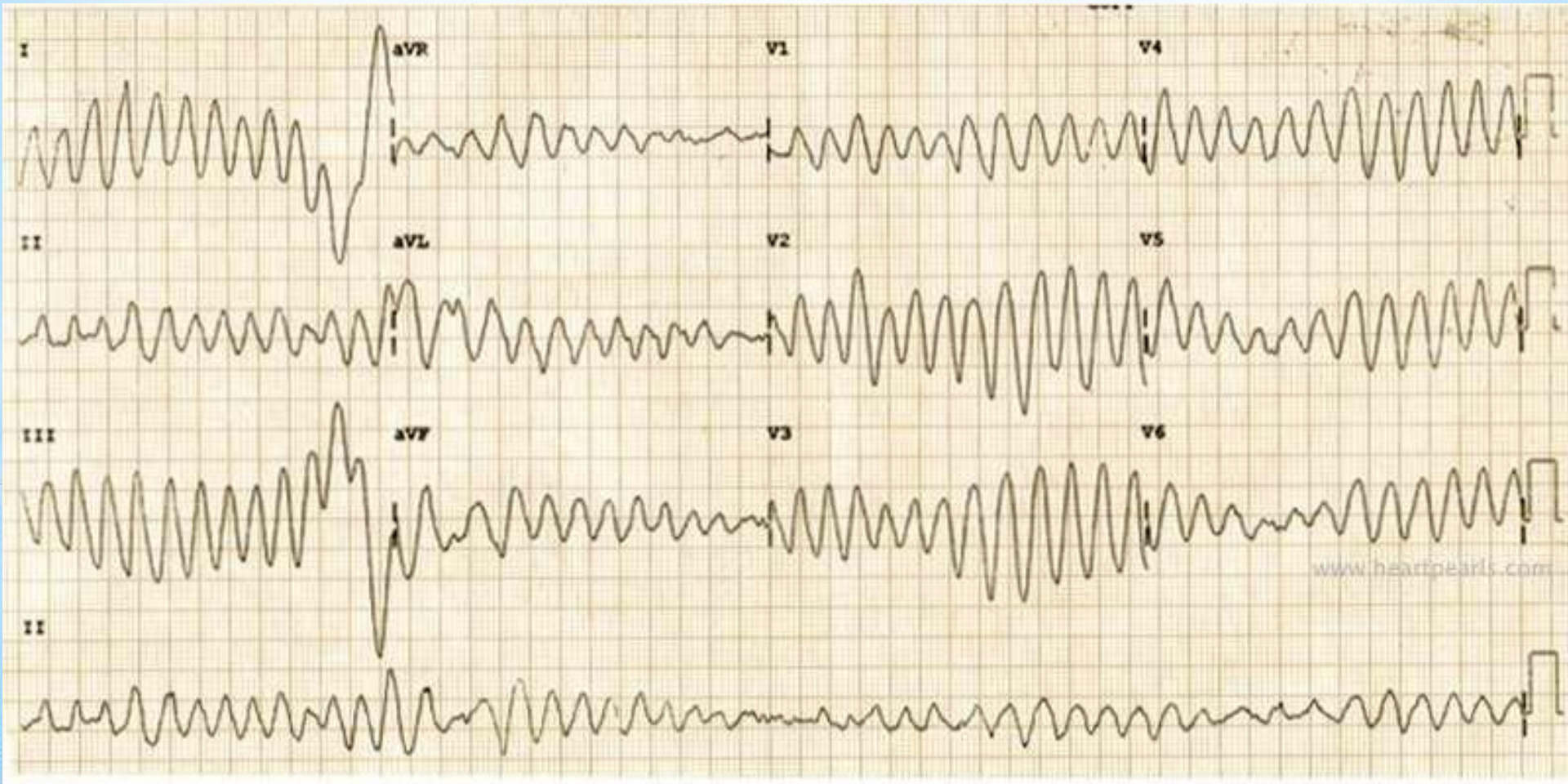
H's	T's
Hypoxia	Toxins
Hypovolemia	Tamponade (cardiac)
Hydrogen ion (acidosis)	Tension pneumothorax
Hypo-/hyperkalemia	Thrombosis, pulmonary
Hypothermia	Thrombosis, coronary

*Shockable : monomorphic VT

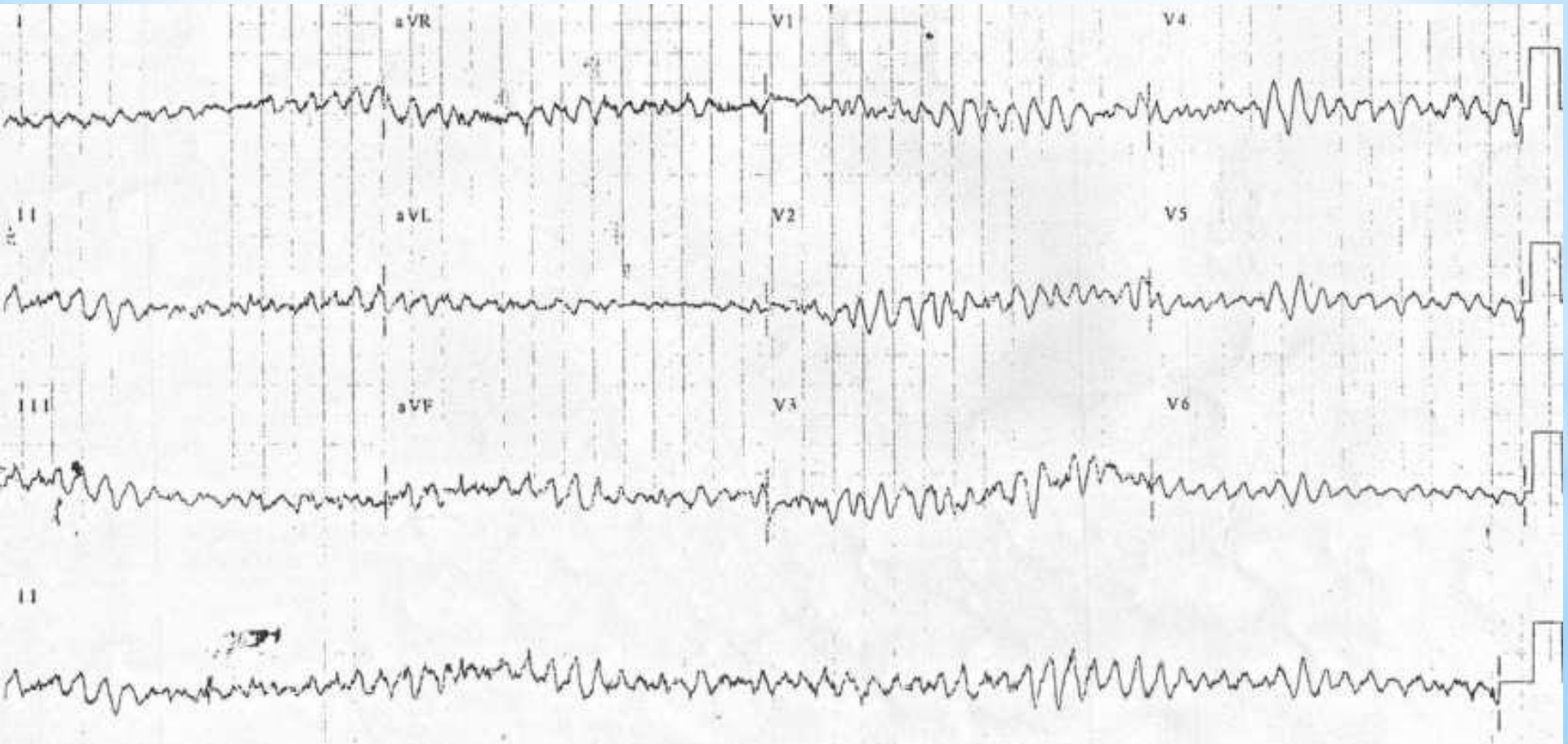
*Shockable : polymophic VT



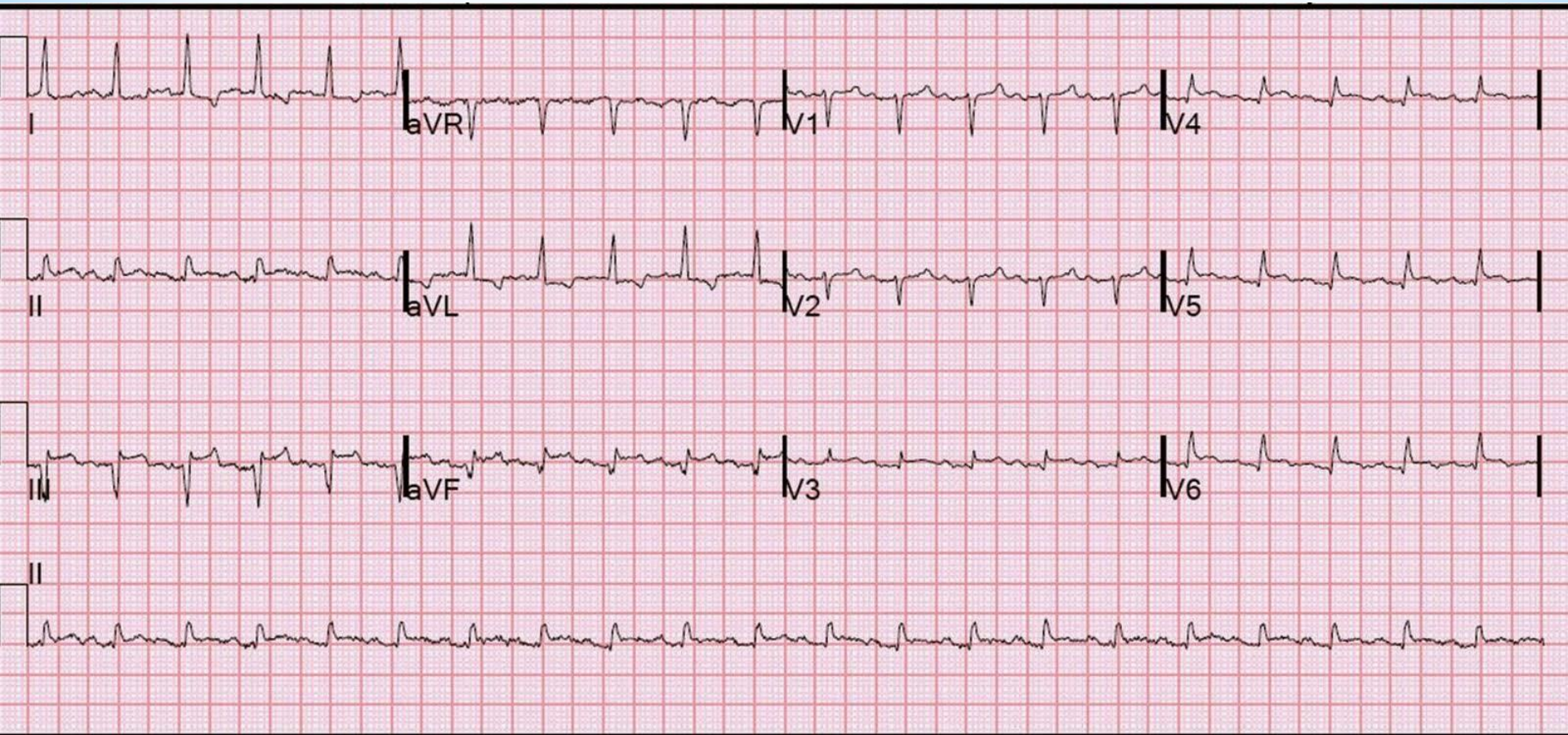
*Shockable : torsades de point



*Shockable : ventricular fibrillation



*Non-shockable : Pulseless electric activity



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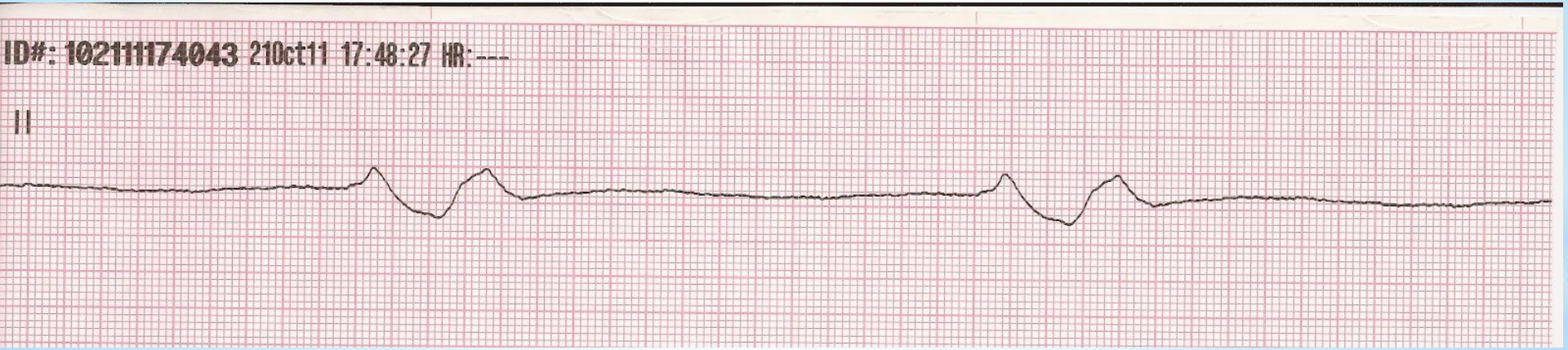

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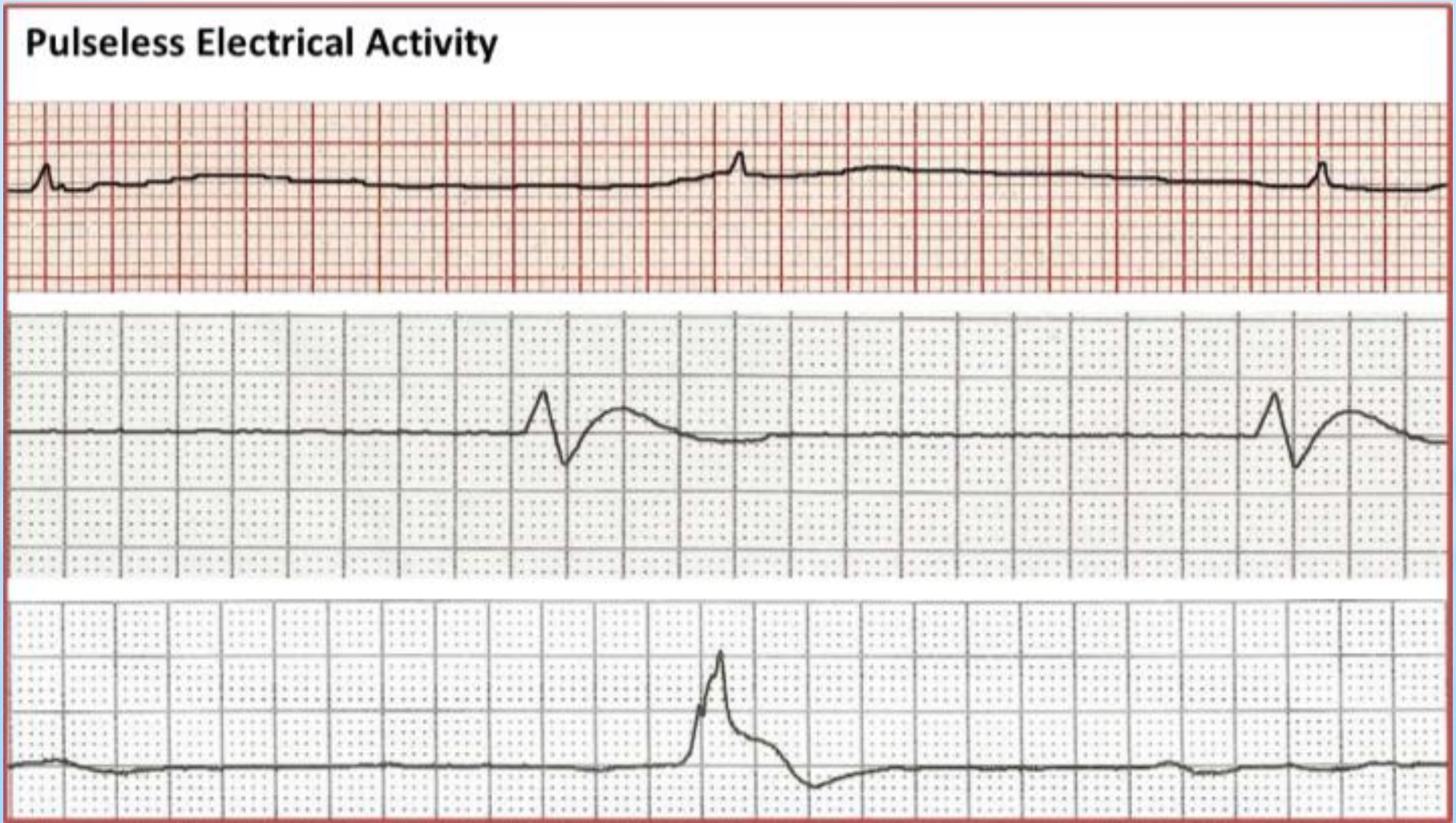
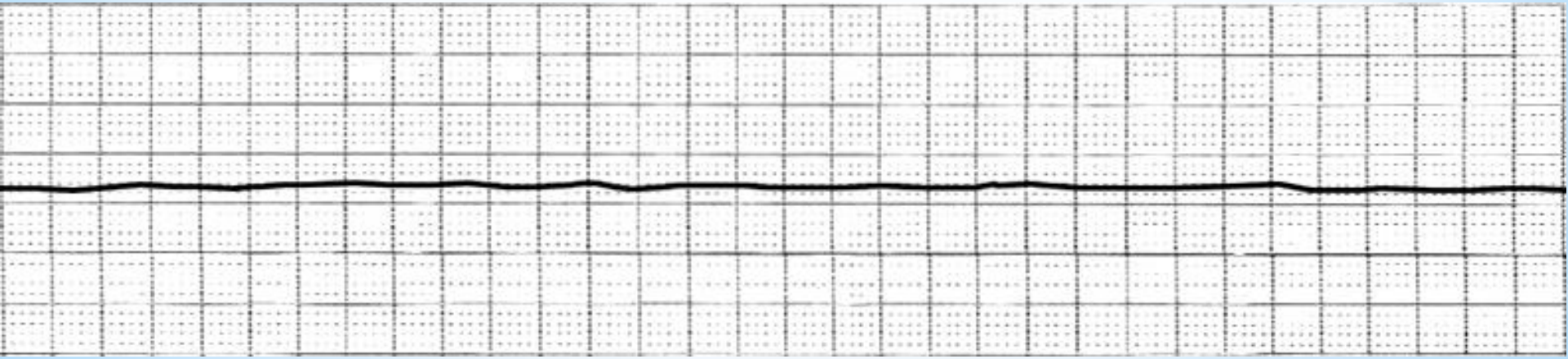


*Non-shockable : Asystole



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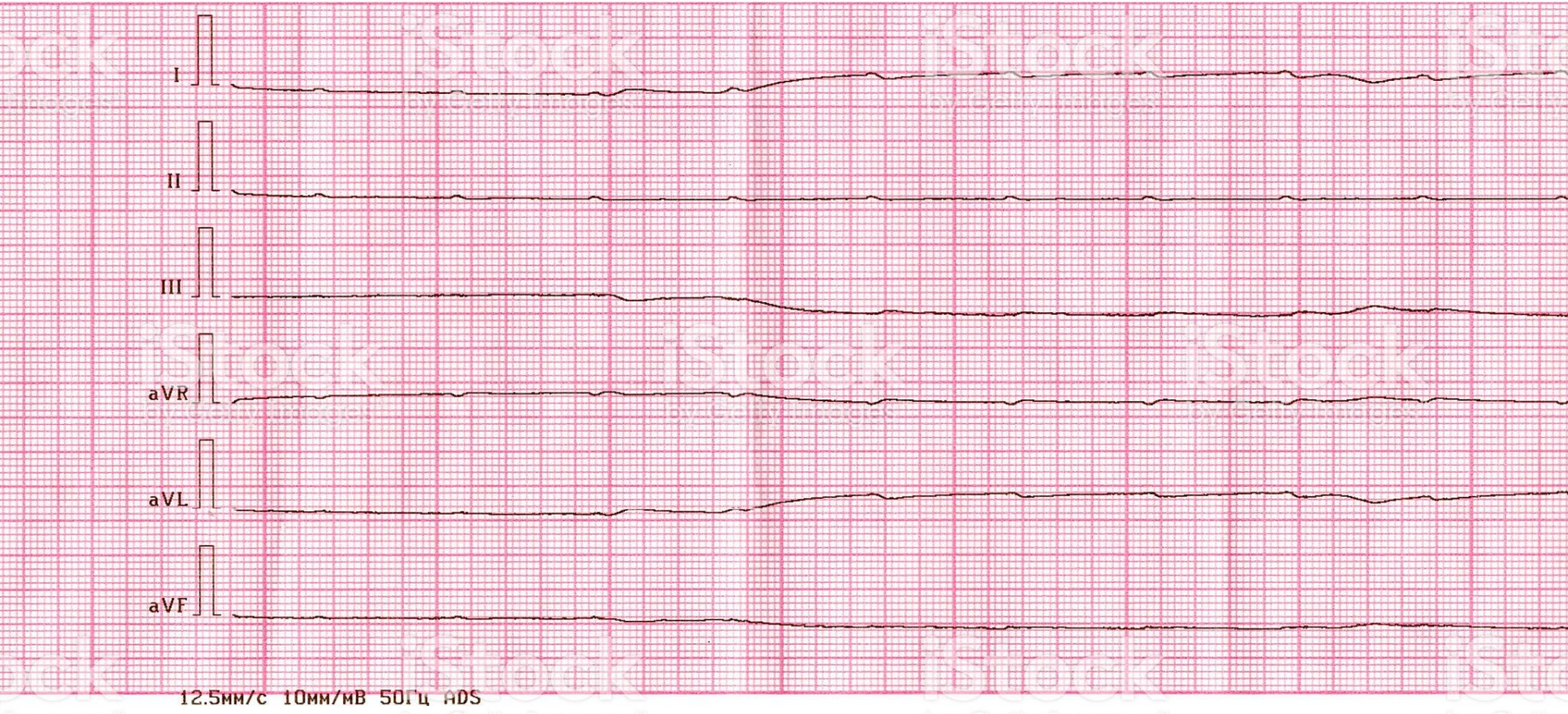

*Medication for arrest rhythm

- ***Drugs during CPR***
  - ***Anti-arrhythmic drugs***
  - ***Vasopressors***
  - ***steroid***
- ***Not Recommended for Routine Use***
  - ***Atropine***
  - ***Sodium Bicarbonate***
  - ***Calcium***
  - ***Fibrinolysis***
  - ***IV Fluids***

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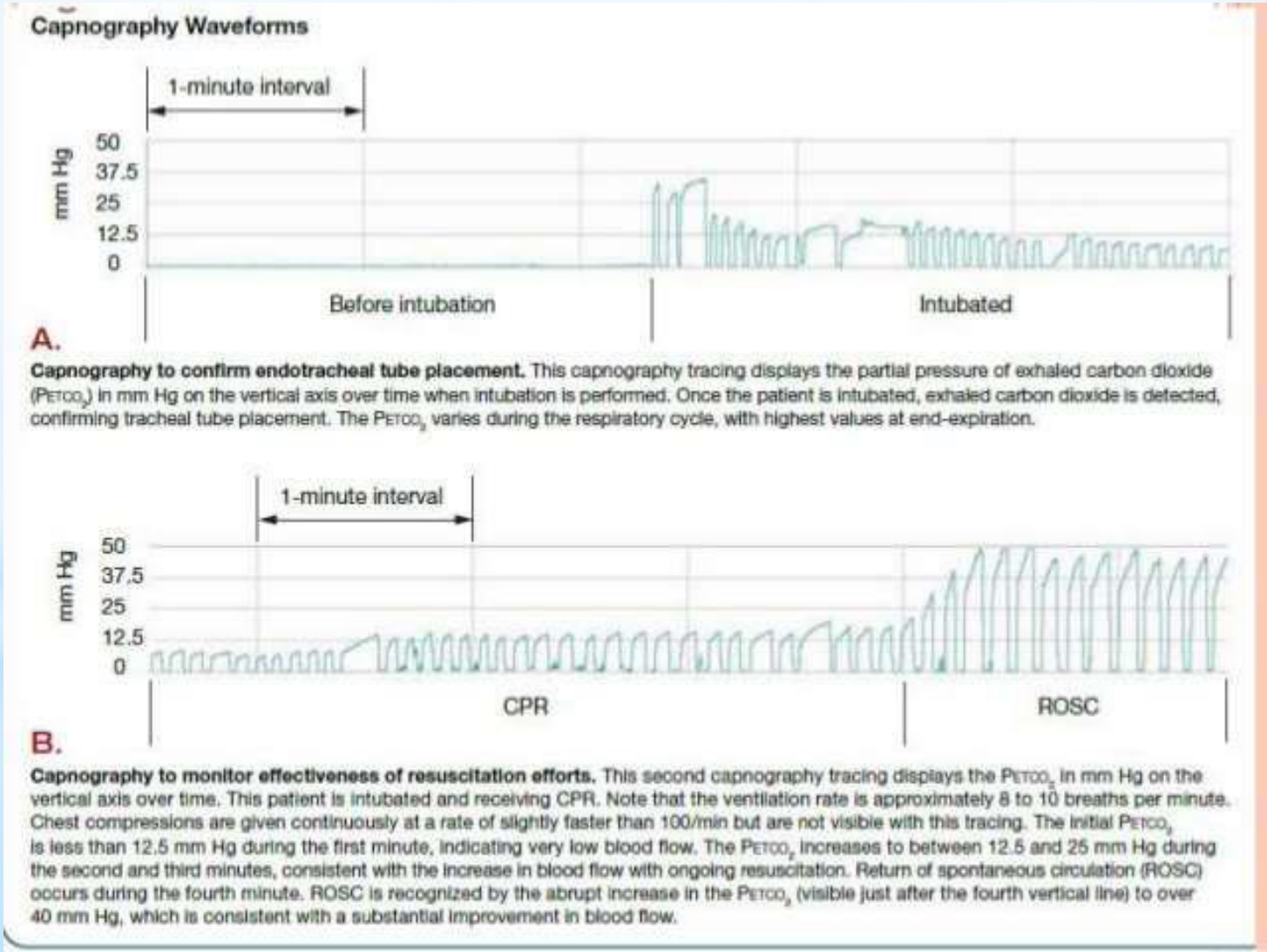
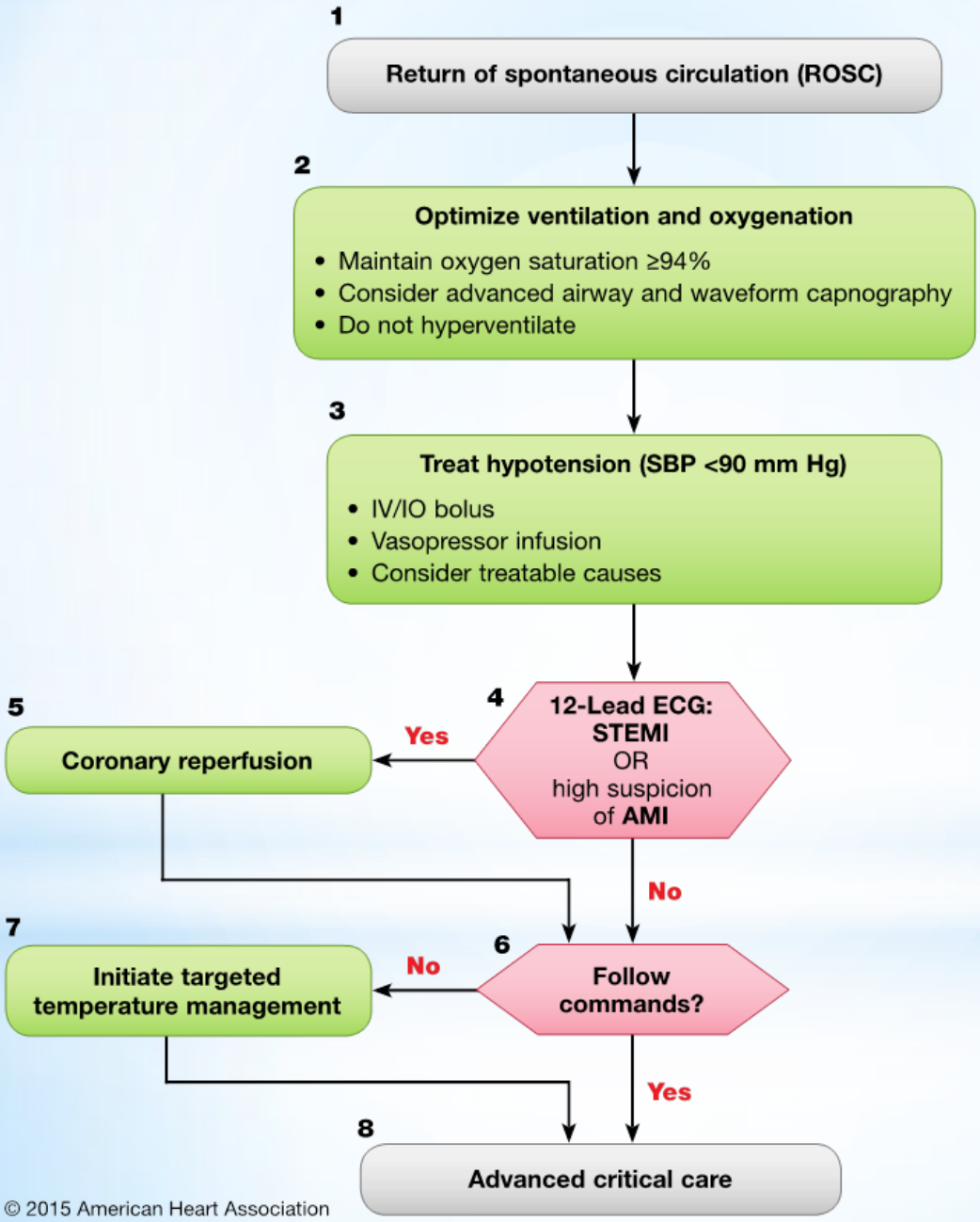
*Prognostication During CPR:End-Tidal CO2



*ROSC

Adult Immediate Post–Cardiac Arrest Care Algorithm—2015 Update



Doses/Details

Ventilation/oxygenation:
Avoid excessive ventilation. Start at 10 breaths/min and titrate to target P_{ETCO_2} of 35-40 mm Hg.
When feasible, titrate F_{IO_2} to minimum necessary to achieve Spo_2 ≥94%.

IV bolus:
Approximately 1-2 L normal saline or lactated Ringer's

Epinephrine IV infusion:
0.1-0.5 mcg/kg per minute (in 70-kg adult: 7-35 mcg per minute)

Dopamine IV infusion:
5-10 mcg/kg per minute

Norepinephrine IV infusion:
0.1-0.5 mcg/kg per minute (in 70-kg adult: 7-35 mcg per minute)

Reversible Causes

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- **H**ypoxia
- **H**ydrogen ion (acidosis)
- **H**ypo-/hyperkalemia
- **H**ypothermia
- **T**ension pneumothorax
- **T**amponade, cardiac
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* Useful Clinical Findings That Are Associated With Poor Neurologic Outcome*

- Absence of pupillary reflex to light at 72 hours or more after cardiac arrest
- Presence of status myoclonus (different from isolated myoclonic jerks) during the first 72 hours after cardiac arrest
- Absence of the N20 somatosensory evoked potential cortical wave 24 to 72 hours after cardiac arrest or after rewarming
- Presence of a marked reduction of the gray-white ratio on brain CT obtained within 2 hours after cardiac arrest
- Extensive restriction of diffusion on brain MRI at 2 to 6 days after cardiac arrest
- Persistent absence of EEG reactivity to external stimuli at 72 hours after cardiac arrest
- Persistent burst suppression or intractable status epilepticus on EEG after rewarming

Absent motor movements, extensor posturing, or myoclonus should not be used alone for predicting outcome.
*Shock, temperature, metabolic derangement, prior sedatives or neuromuscular blockers, and other clinical factors should be considered carefully because they may affect results or interpretation of some tests.
Abbreviations: CT, computed tomography; EEG, electroencephalogram; MRI, magnetic resonance imaging.

Multiple System Approach to Post-Cardiac Arrest Care

Ventilation

- Capnography
  - Rationale: Confirm secure airway and titrate ventilation
  - Endotracheal tube when possible for comatose patients
  - $Petco_2$~35–40 mm Hg
  - $Paco_2$~40–45 mm Hg
- Chest X-ray
  - Rationale: Confirm secure airway and detect causes or complications of arrest: pneumonitis, pneumonia, pulmonary edema
- Pulse Oximetry/ABG
  - Rationale: Maintain adequate oxygenation and minimize Fio_2
  - Spo_2 ≥94%
  - Pao_2~100 mm Hg
  - Reduce Fio_2 as tolerated
  - Pao_2/Fio_2 ratio to follow acute lung injury
- Mechanical Ventilation
  - Rationale: Minimize acute lung injury, potential oxygen toxicity
  - Tidal Volume 6–8 mL/kg
  - Titrate minute ventilation to $Petco_2$~35–40 mm Hg $Paco_2$~40–45 mm Hg
  - Reduce Fio_2 as tolerated to keep Spo_2 or Sao_2 ≥94%

Hemodynamics

- Frequent Blood Pressure Monitoring/Arterial-line
  - Rationale: Maintain perfusion and prevent recurrent hypotension
  - Mean arterial pressure ≥65 mm Hg or systolic blood pressure ≥90 mm Hg

- Treat Hypotension
  - Rationale: Maintain perfusion
  - Fluid bolus if tolerated
  - Dopamine 5–10 mcg/kg per min
  - Norepinephrine 0.1–0.5 mcg/kg per min
  - Epinephrine 0.1–0.5 mcg/kg per min

Cardiovascular

- Continuous Cardiac Monitoring
  - Rationale: Detect recurrent arrhythmia
  - No prophylactic antiarrhythmics
  - Treat arrhythmias as required
  - Remove reversible causes
- 12-lead ECG/Troponin
  - Rationale: Detect Acute Coronary Syndrome/ST-Elevation Myocardial Infarction; Assess QT interval
- Treat Acute Coronary Syndrome
  - Aspirin/heparin
  - Transfer to acute coronary treatment center
  - Consider emergent PCI or fibrinolysis
- Echocardiogram
  - Rationale: Detect global stunning, wall-motion abnormalities, structural problems or cardiomyopathy
- Treat Myocardial Stunning
  - Fluids to optimize volume status (requires clinical judgment)
  - Dobutamine 5–10 mcg/kg per min
  - Mechanical augmentation (IABP)

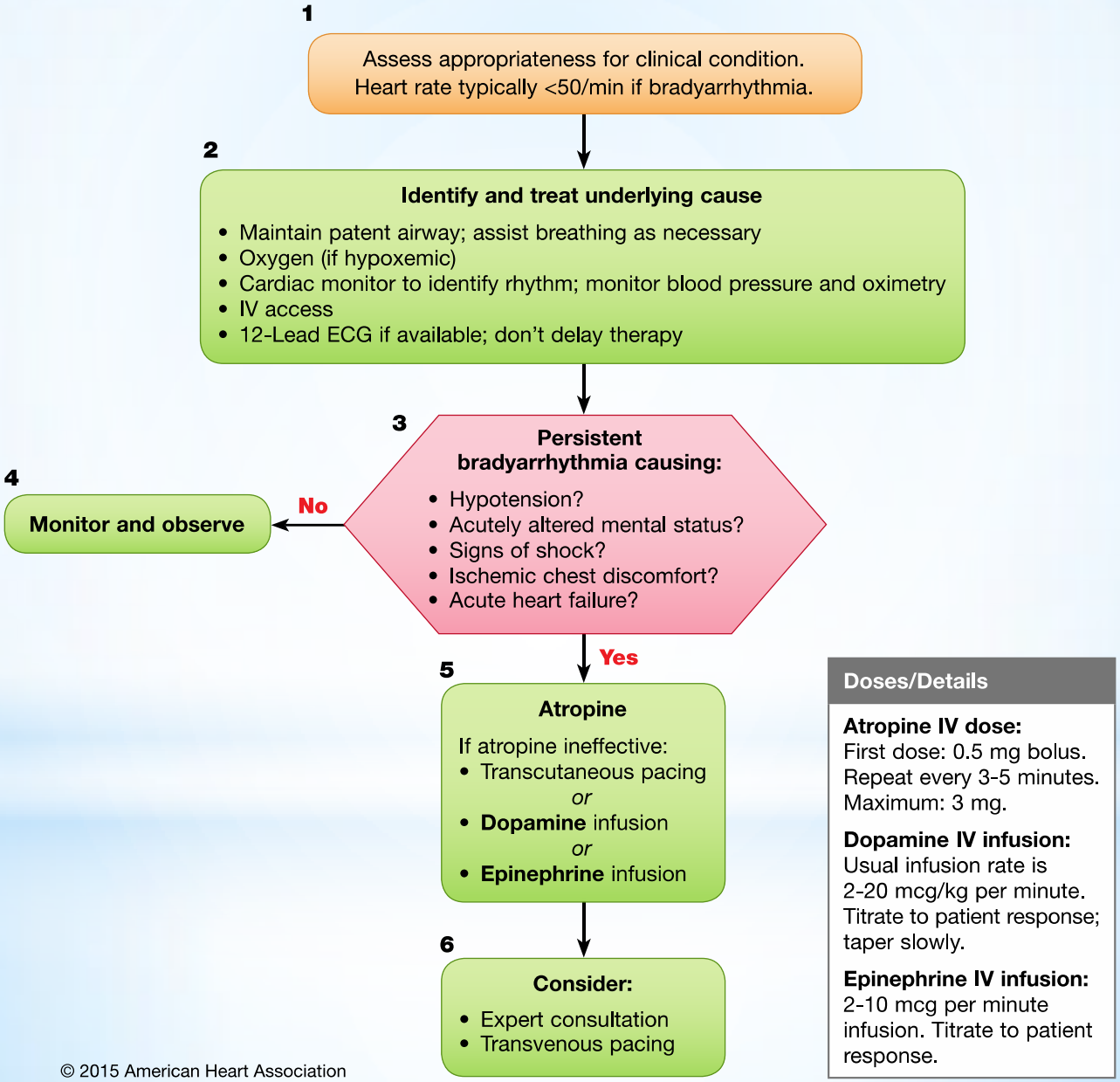
Neurological

- Serial Neurological Exam
  - Rationale: Serial examinations define coma, brain injury, and prognosis
  - Response to verbal commands or physical stimulation
  - Pupillary light and corneal reflex, spontaneous eye movement
  - Gag, cough, spontaneous breaths
- EEG Monitoring If Comatose
  - Rationale: Exclude seizures
  - Anticonvulsants if seizing
- Core Temperature Measurement If Comatose
  - Rationale: Minimize brain injury and improve outcome
  - Prevent hyperpyrexia >37.7°C
  - Induce therapeutic hypothermia if no contraindications
  - Cold IV fluid bolus 30 mL/kg if no contraindication
  - Surface or endovascular cooling for 32°C–34°C×24 hours
  - After 24 hours, slow rewarming 0.25°C/hr
- Consider Non-enhanced CT Scan
  - Rationale: Exclude primary intracranial process
- Sedation/Muscle Relaxation
  - Rationale: To control shivering, agitation, or ventilator desynchrony as needed

Metabolic

- Serial Lactate
  - Rationale: Confirm adequate perfusion
- Serum Potassium
  - Rationale: Avoid hypokalemia which promotes arrhythmias
  - Replace to maintain K >3.5 mEq/L
- Urine Output, Serum Creatinine
  - Rationale: Detect acute kidney injury
  - Maintain euvolemia
  - Renal replacement therapy if indicated
- Serum Glucose
  - Rationale: Detect hyperglycemia and hypoglycemia
  - Treat hypoglycemia (<80 mg/dL) with dextrose
  - Treat hyperglycemia to target glucose 144–180 mg/dL
  - Local insulin protocols
- Avoid Hypotonic Fluids
  - Rationale: May increase edema, including cerebral edema

Adult Bradycardia With a Pulse Algorithm



Doses/Details

Atropine IV dose:
First dose: 0.5 mg bolus.
Repeat every 3-5 minutes.
Maximum: 3 mg.

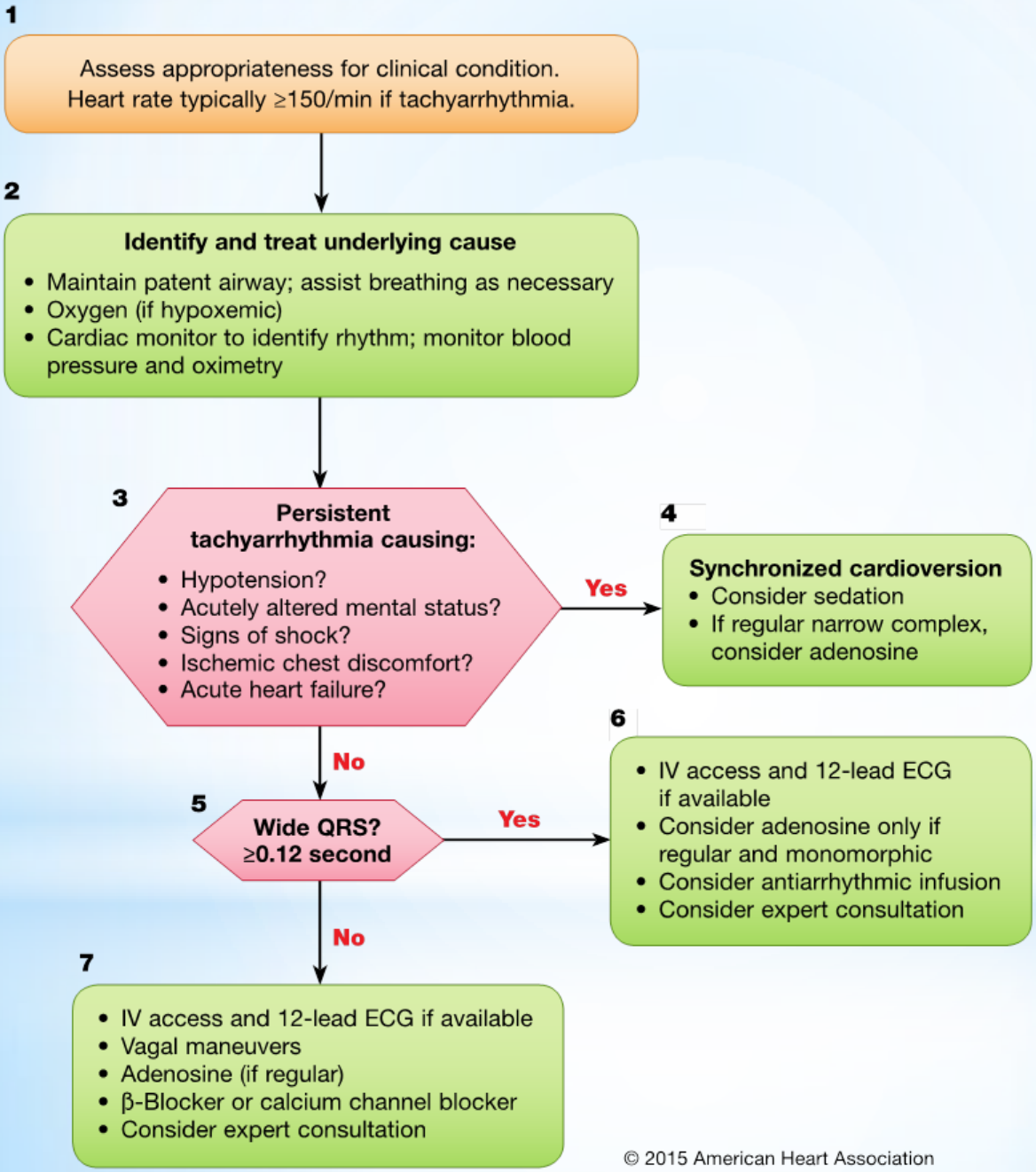
Dopamine IV infusion:
Usual infusion rate is 2-20 mcg/kg per minute.
Titrate to patient response; taper slowly.

Epinephrine IV infusion:
2-10 mcg per minute infusion. Titrate to patient response.

*Therapy for bradycardia

- ***Atropine***
- ***Pacing***
- ***Alternative drugs***
    - ***Dopamine***
    - ***Epinephrine***
    - ***Isoproterenol***

Adult Tachycardia With a Pulse Algorithm



Doses/Details

Synchronized cardioversion:
Initial recommended doses:
- Narrow regular: 50-100 J
- Narrow irregular: 120-200 J biphasic or 200 J monophasic
- Wide regular: 100 J
- Wide irregular: defibrillation dose (*not* synchronized)

Adenosine IV dose:
First dose: 6 mg rapid IV push; follow with NS flush.
Second dose: 12 mg if required.

Antiarrhythmic Infusions for Stable Wide-QRS Tachycardia

Procainamide IV dose:
20-50 mg/min until arrhythmia suppressed, hypotension ensues, QRS duration increases >50%, or maximum dose 17 mg/kg given. Maintenance infusion: 1-4 mg/min. Avoid if prolonged QT or CHF.

Amiodarone IV dose:
First dose: 150 mg over 10 minutes. Repeat as needed if VT recurs. Follow by maintenance infusion of 1 mg/min for first 6 hours.

Sotalol IV dose:
100 mg (1.5 mg/kg) over 5 minutes. Avoid if prolonged QT.

*Classifications of tachyarrhythmia

- **Narrow–QRS-complex (SVT) tachycardias (QRS <0.12 second), in order of frequency**
  - Sinus tachycardia
  - Atrial fibrillation
  - Atrial flutter
  - AV nodal reentry
  - Accessory pathway–mediated tachycardia
  - Atrial tachycardia (including automatic and reentry forms)
  - Multifocal atrial tachycardia (MAT)
  - Junctional tachycardia (rare in adults)

- **Wide–QRS-complex tachycardias (QRS ≥0.12 second)**
  - Ventricular tachycardia (VT) and ventricular fibrillation (VF)
  - SVT with aberrancy
  - Pre-excited tachycardias (Wolff-Parkinson-White [WPW] syndrome)
  - Ventricular paced rhythms

Classifications of tachyarrhythmia

- **Regular narrow-complex tachycardia**
  - Sinus tachycardia
  - SVT
- **Wide–QRS-complex tachycardias (QRS ≥0.12 second)**
  - Ventricular tachycardia (VT) and ventricular fibrillation (VF)
  - SVT with aberrancy
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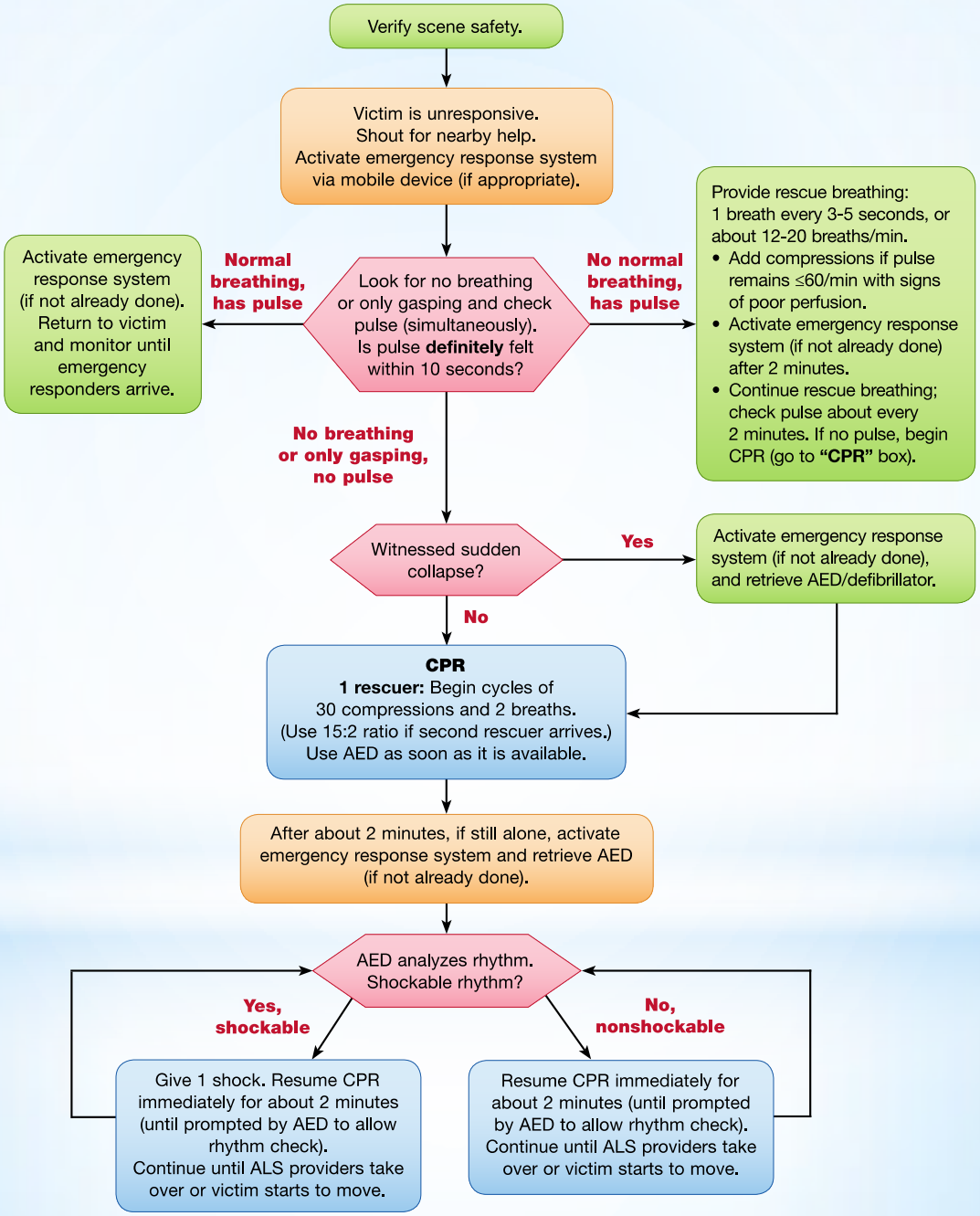
  - Ventricular paced rhythms
- **Irregular tachycardia**
  - Atrial fibrillation and flutter
  - Polymophic VT

*PALS

BLS Healthcare Provider

Pediatric Cardiac Arrest Algorithm for the Single Rescuer—2015 Update



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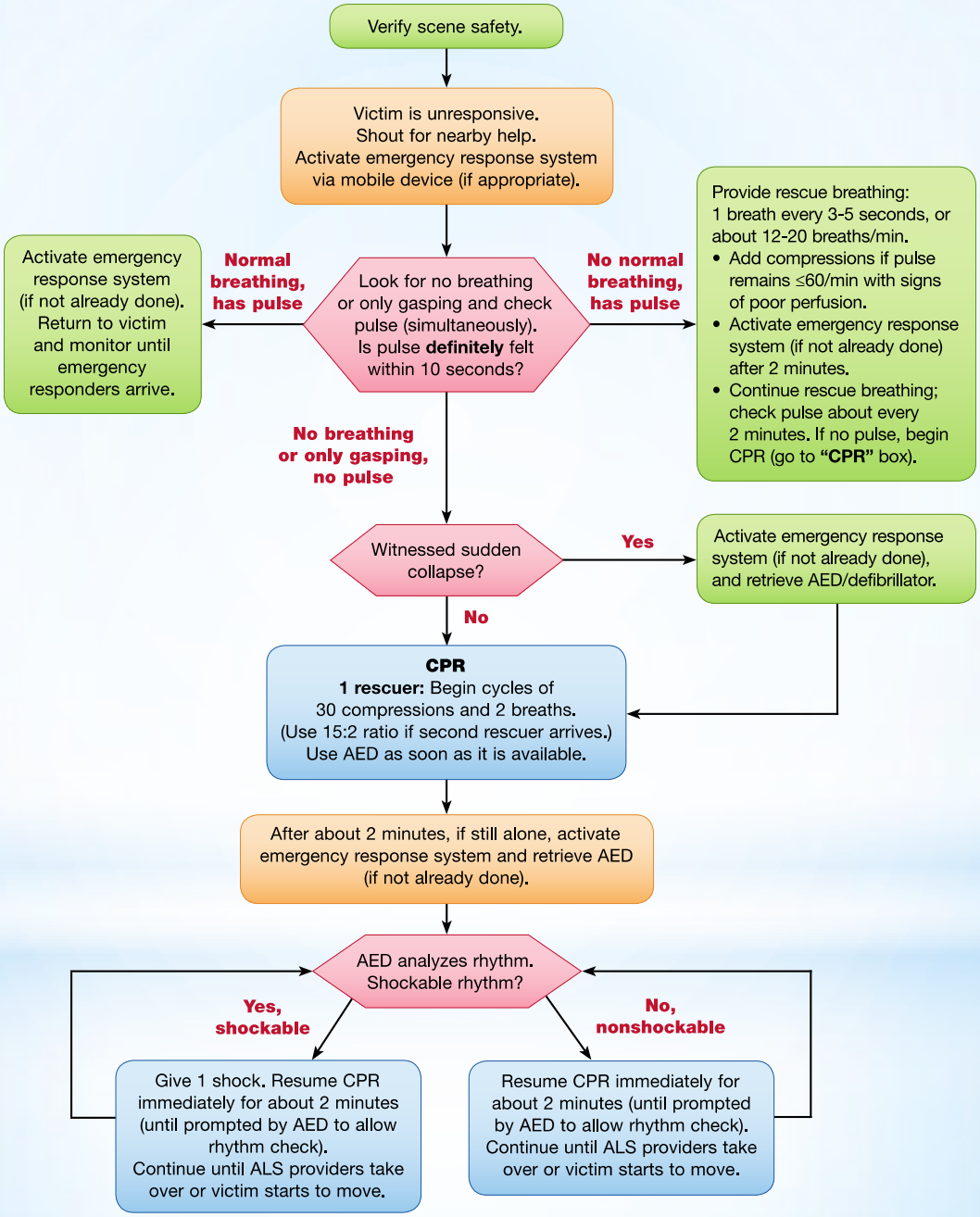
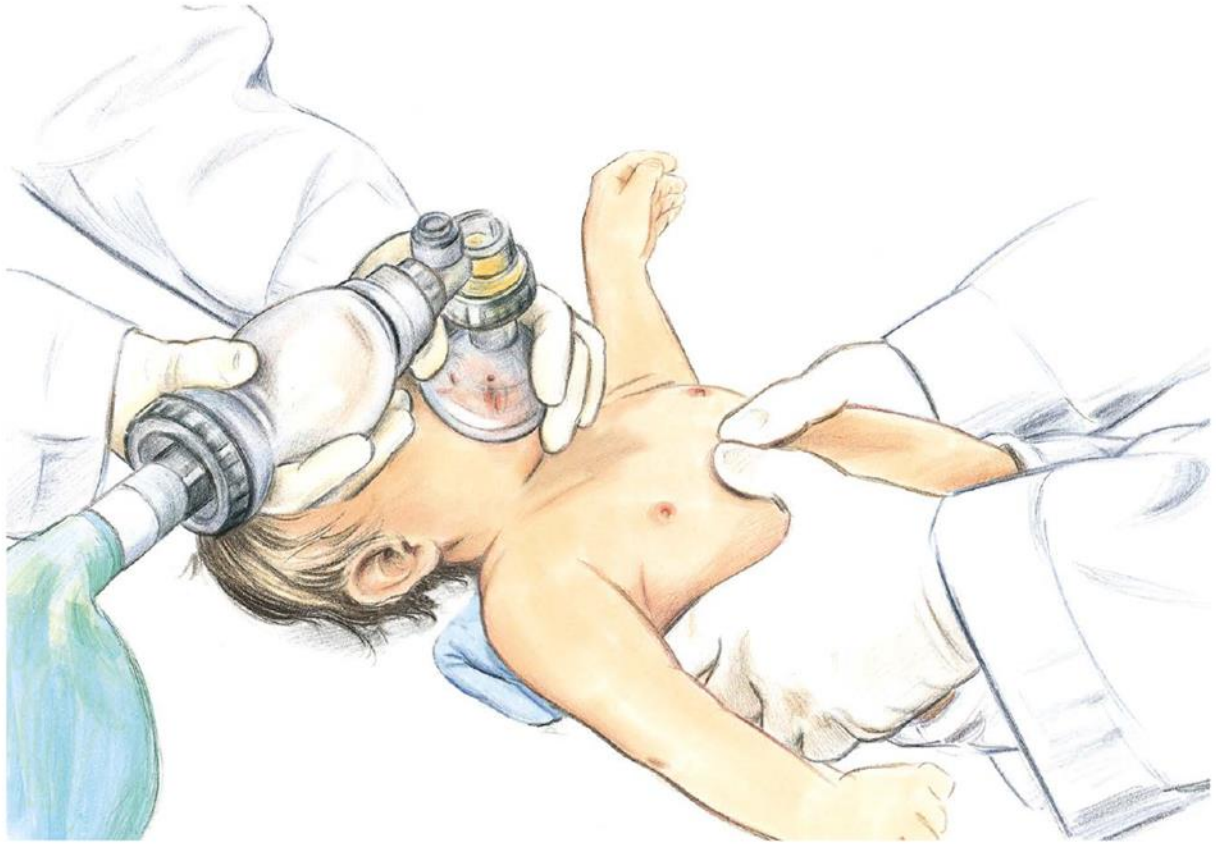
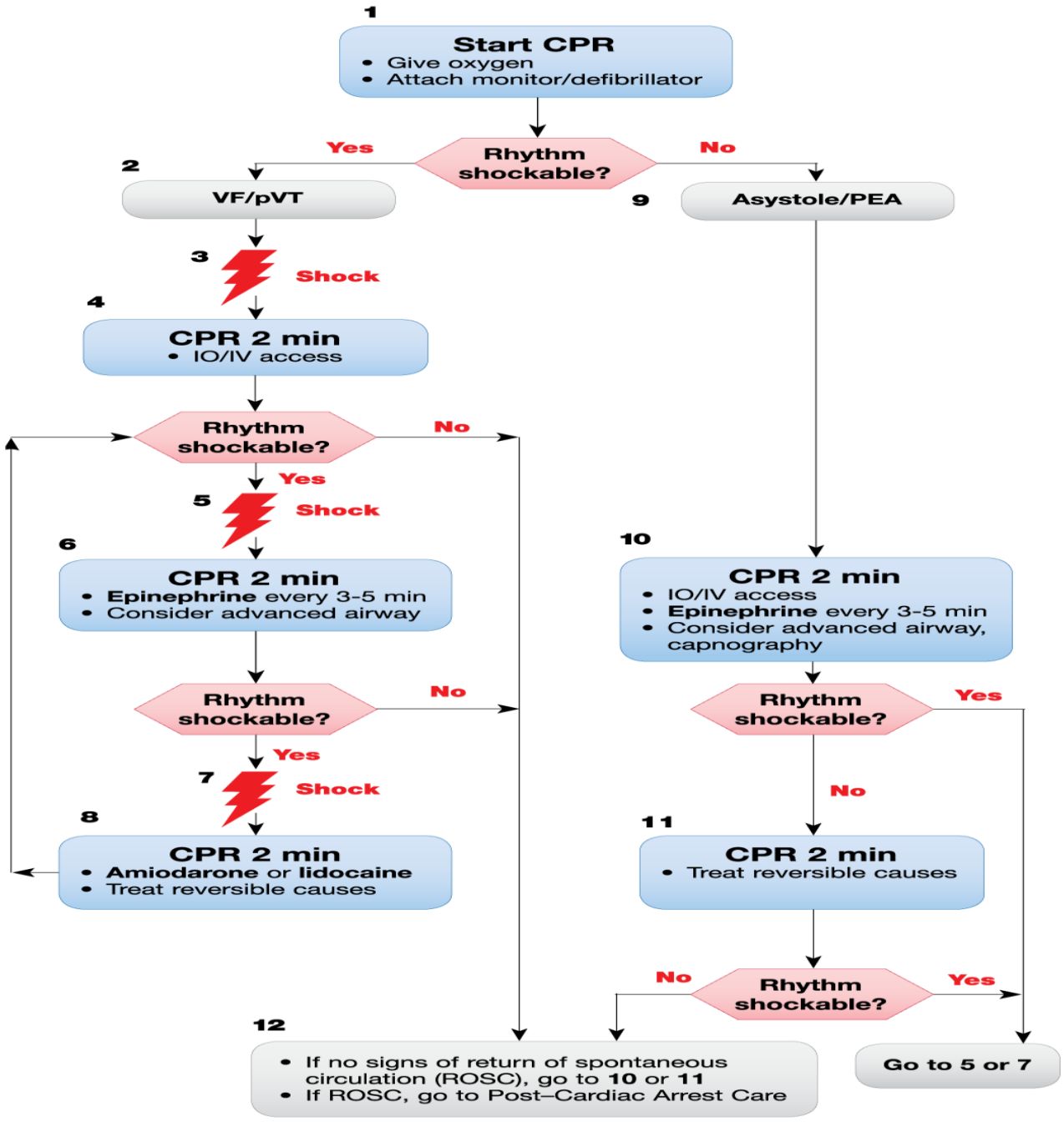


Two thumb-encircling hands chest compression in infant (2 rescuers).



Pediatric Cardiac Arrest Algorithm—2018 Update



CPR Quality

- Push hard (≥⅓ of anteroposterior diameter of chest) and fast (100-120/min) and allow complete chest recoil.
- Minimize interruptions in compressions.
- Avoid excessive ventilation.
- Change compressor every 2 minutes, or sooner if fatigued.
- If no advanced airway, 15:2 compression-ventilation ratio.

Shock Energy for Defibrillation

First shock 2 J/kg, second shock 4 J/kg, subsequent shocks ≥4 J/kg, maximum 10 J/kg or adult dose

Drug Therapy

- **Epinephrine IO/IV dose:** 0.01 mg/kg (0.1 mL/kg of the 0.1 mg/mL concentration). Repeat every 3-5 minutes. If no IO/IV access, may give endotracheal dose: 0.1 mg/kg (0.1 mL/kg of the 1 mg/mL concentration).
- **Amiodarone IO/IV dose:** 5 mg/kg bolus during cardiac arrest. May repeat up to 2 times for refractory VF/pulseless VT.

  -OR-

  Lidocaine IO/IV dose: Initial: 1 mg/kg loading dose. Maintenance: 20-50 mcg/kg per minute infusion (repeat bolus dose if infusion initiated >15 minutes after initial bolus therapy).

Advanced Airway

- Endotracheal intubation or supraglottic advanced airway
- Waveform capnography or capnometry to confirm and monitor ET tube placement
- Once advanced airway in place, give 1 breath every 6 seconds (10 breaths/min) with continuous chest compressions

Return of Spontaneous Circulation (ROSC)

- Pulse and blood pressure
- Spontaneous arterial pressure waves with intra-arterial monitoring

Reversible Causes

- **H**ypovolemia
- **H**ypoxia
- **H**ydrogen ion (acidosis)
- **H**ypoglycemia
- **H**ypo-/hyperkalemia
- **H**ypothermia
- **T**ension pneumothorax
- **T**amponade, cardiac
- **T**oxins
- **T**hrombosis, pulmonary
- **T**hrombosis, coronary

*END