Cardiopulmonary resuscitation

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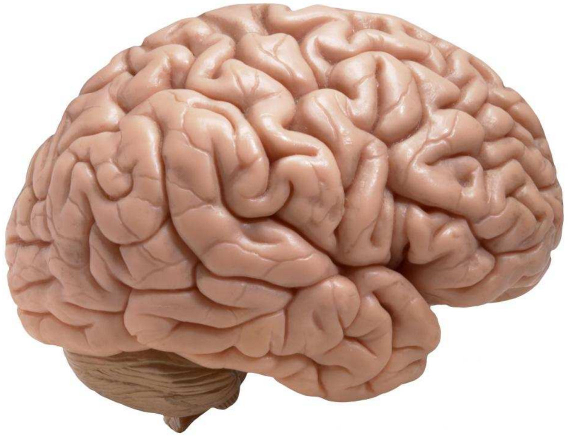
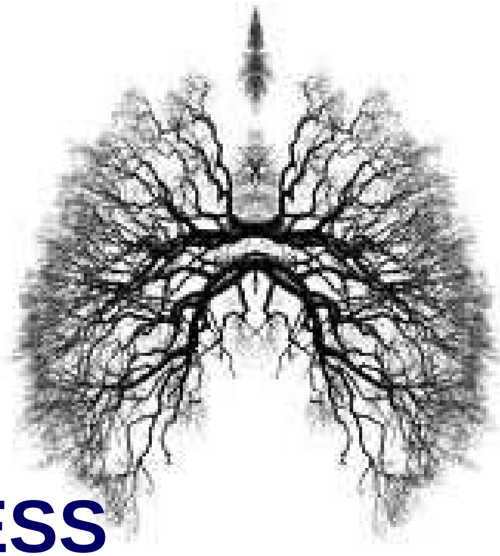
Praha

Cardiopulmonary resuscitation

a set of logically proceeding
diagnostic and therapeutic measures
aiming at
immediate return of spontaneous circulation
of oxygenated blood
in a person suffering from
a reversible failure of vital functions

Vital functions



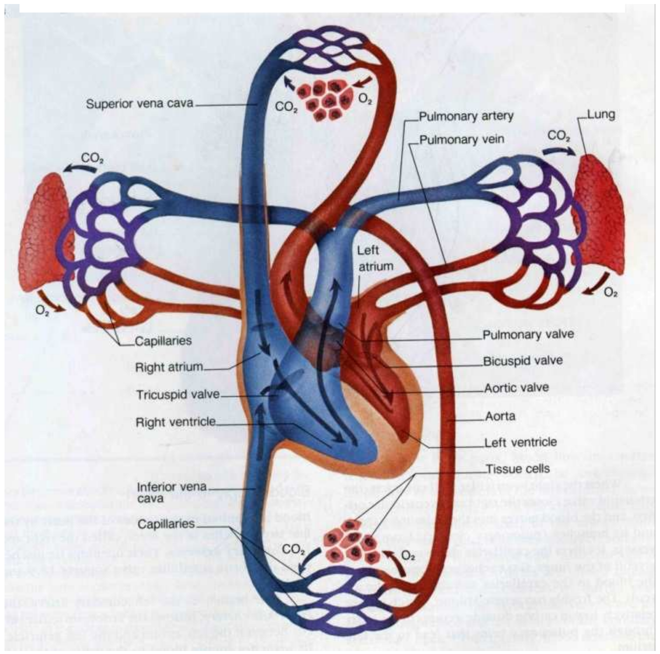


CONSCIOUSNESS

BREATHING

CIRCULATION

HOMEOSTASIS



References

EUROPEAN
RESUSCITATION
COUNCIL

www.erc.edu

American Heart
Association

Learn and Live

www.americanheart.org

History

Peter J. Safar (1924 Vienna - 2003)

- founder of the 1. dept. of anaesthesiology - Lima, Peru, 1953
- rediscovered head tilt+chin lift (A) + mouth-to-mouth breathing (B)
- **A-B-C sequence in the book „ABC of resuscitation“ 1957**
- influenced Asmund Laerdal (doll maker) to produce ResusciAnne
- 3 times nominated for Nobel prize
- International Resuscitation Centre → Safar Centre for Resuscitation Research, Pittsburgh, USA (http://www.safar.pitt.edu)

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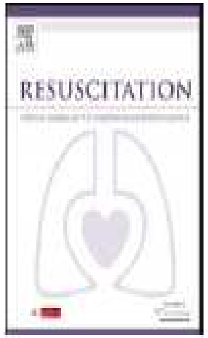
journal homepage: www.elsevier.com/locate/resuscitation



European Resuscitation Council Guidelines for Resuscitation 2010 Section 1. Executive summary

Jerry P. Nolan[a,*], Jasmeet Soar[b], David A. Zideman[c], Dominique Biarent[d], Leo L. Bossaert[e], Charles Deakin[f], Rudolph W. Koster[g], Jonathan Wyllie[h], Bernd Böttiger[i], on behalf of the ERC Guidelines Writing Group[1]

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43/233 pages

Cardiac arrest - epidemiology

- leading cause of death in Europe
- 350-700 000 persons annually
  - ventricular fibrillation 25-30%, decreasing
- out-of-hospital CA: 49-66/100 000
- in-hospital CA: 3.3 (1-5)/1000 admitted
  - 82.5% cardiac, 4.3% pulmonary, 3.1% trauma, 2.2 % stroke
- survival to hospital discharge:
  - after out-of-hosp. CA ~ 6%
  - after in-hospital CA ~ 17%

CPR sequence


Peter J. Safar

- **A** = airways, ie. airways are patent
- **B** = breathing, ie. ventilation is sufficient
- **C** = circulation, ie. circulation is sufficient
- **D** = drugs
  = dysfunction of CNS
  = definitive diagnosis

- **E** = exposure of the whole patient

CPR phases

- **Basic life support (BLS)**
  - ABC
- **Advanced life support (ALS)**
  - ABC with adjuncts and devices + DEF
- **Post-resuscitation care**
  - GHI

A
B
C
D
E
F
G
H
I

CPR phases A-I

Basic

A = Airways

B = Breathing

C = Circulation

Advanced

D = Drugs + O_2

E = EKG

F = Fibrillation treatment

Post-resusciation care

G = Gauging (ie. cause)?

H = Hypothermia

I = Intensive care

1. Phone
   probability of CA in the first hour of MI 20-30%
2. Immediate CPR can increase probability of survival 2-3x
3. Early (in 3-5 min) defi = chance for survival 50-75%
   each minute of delay before defi reduces probability of survival
   by 10-12%, with concomittant CPR by 3-4%
4. Therapeutic hypothermia improves quality of survival

Reversible causes of cardiac arrest

4 Hs

- Hypoxie
- Hypovolemia
- Hypothermia
- Hypo-/hyperkalemia

4 Ts

- Thrombosis (coronary or pulmonary)
- Tension pneumothorax
- Tamponade
- Toxins

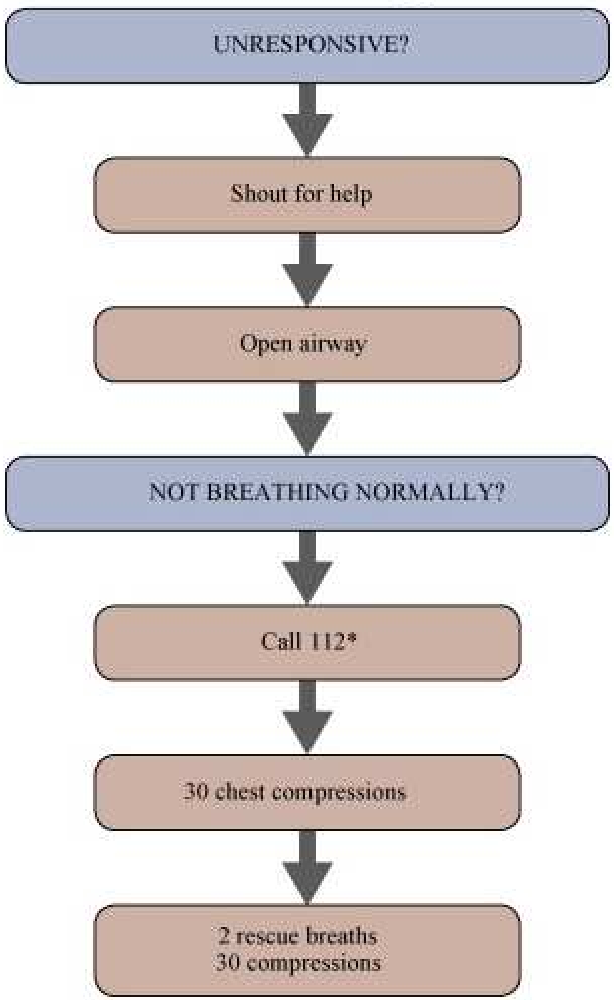
Basic CPR

Basic CPR

A

B

C



Recognition of cardiac arrest

1. Check for the response?

Recognition of cardiac arrest

1. Check for the response?

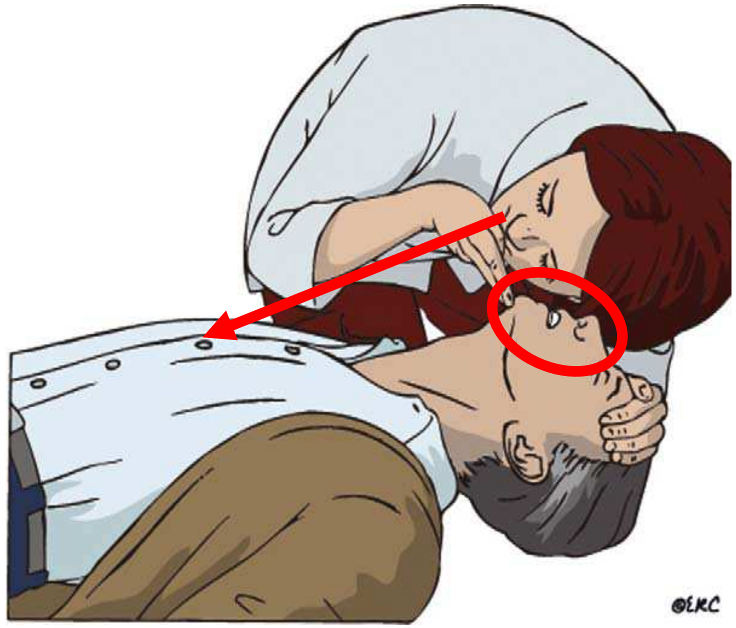
2. If no, shout for help!

Opening the airways

3. Head tilt + chin lift

~~**+ jaw thrust**~~

Opening the airways



3. Head tilt + chin lift

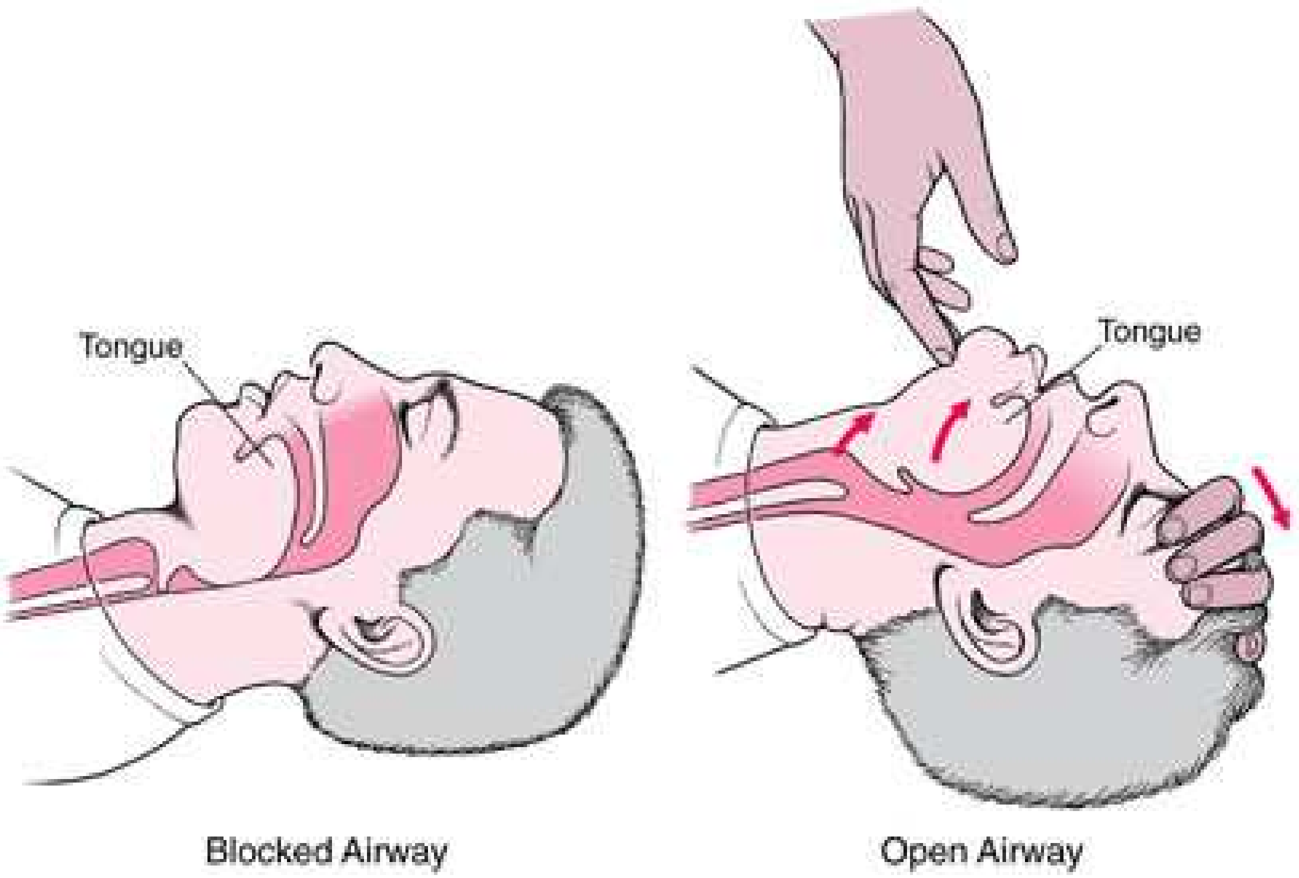
~~**+ jaw thrust**~~

4. Look
Listen
Feel

no more than 10 s!

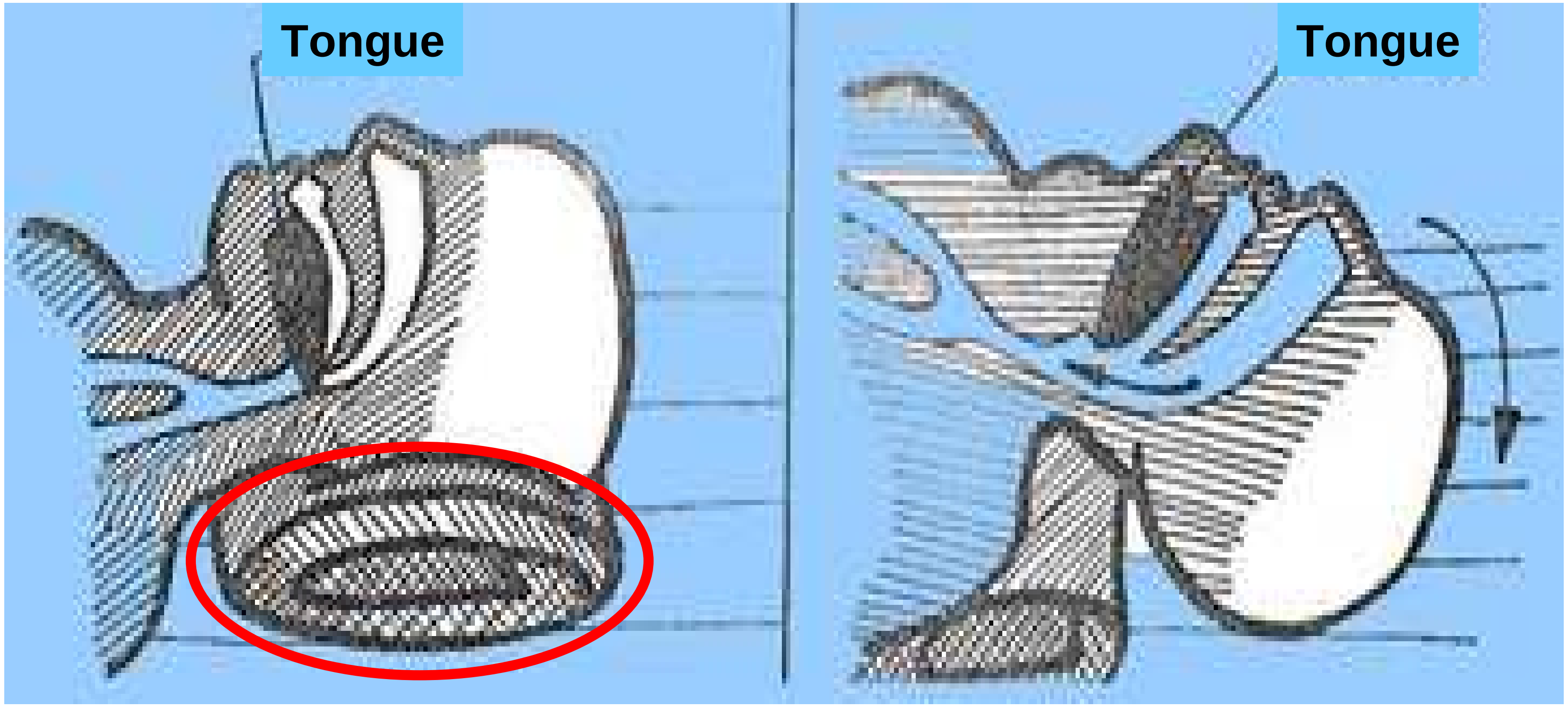
Leading cause of airways obstruction

obstruction by tongue

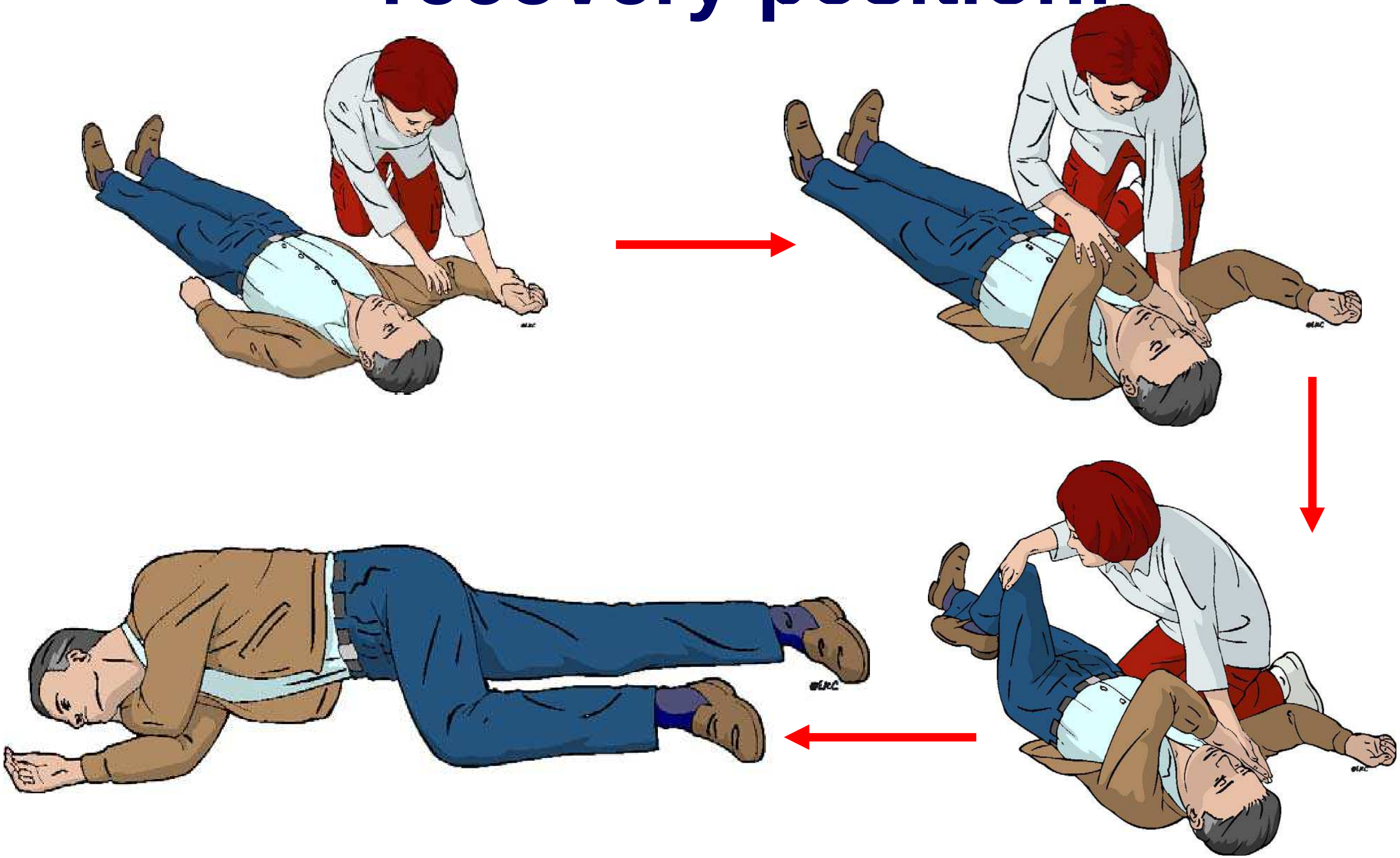


Obstruction by tongue

leading cause of airways obstruction



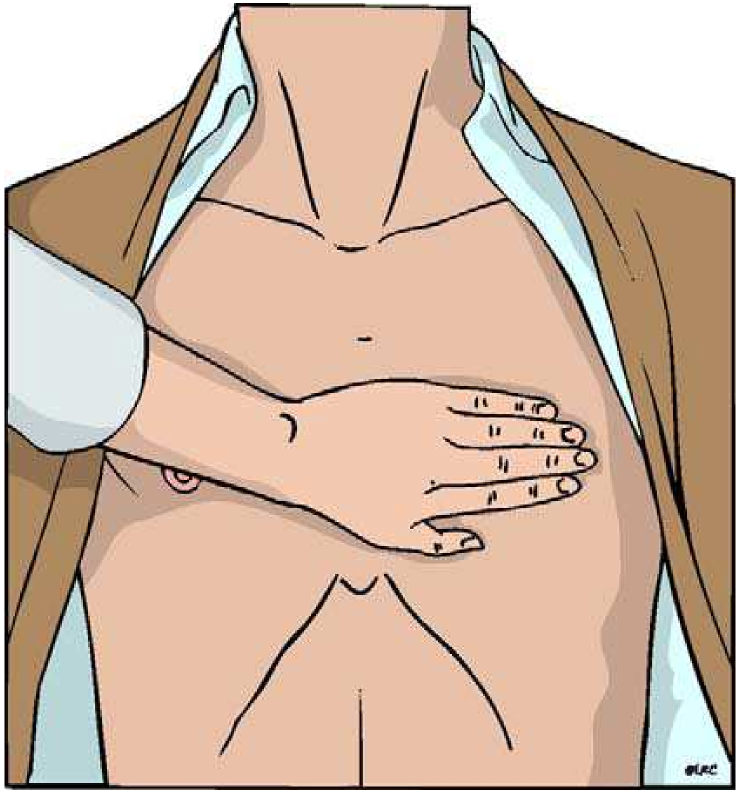
In breathing victim
– recovery position!

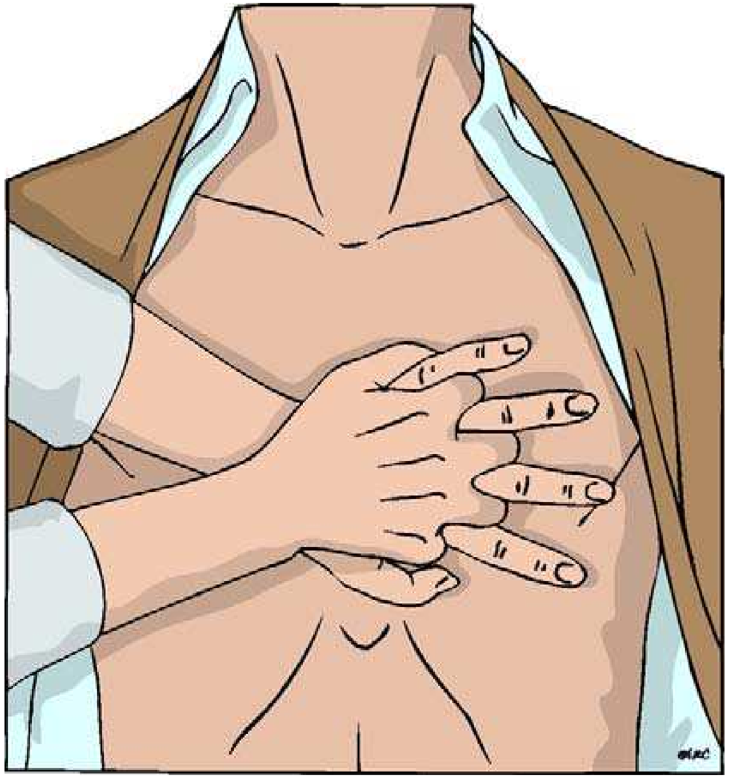


Not breathing normally!

↓

External chest compresion!



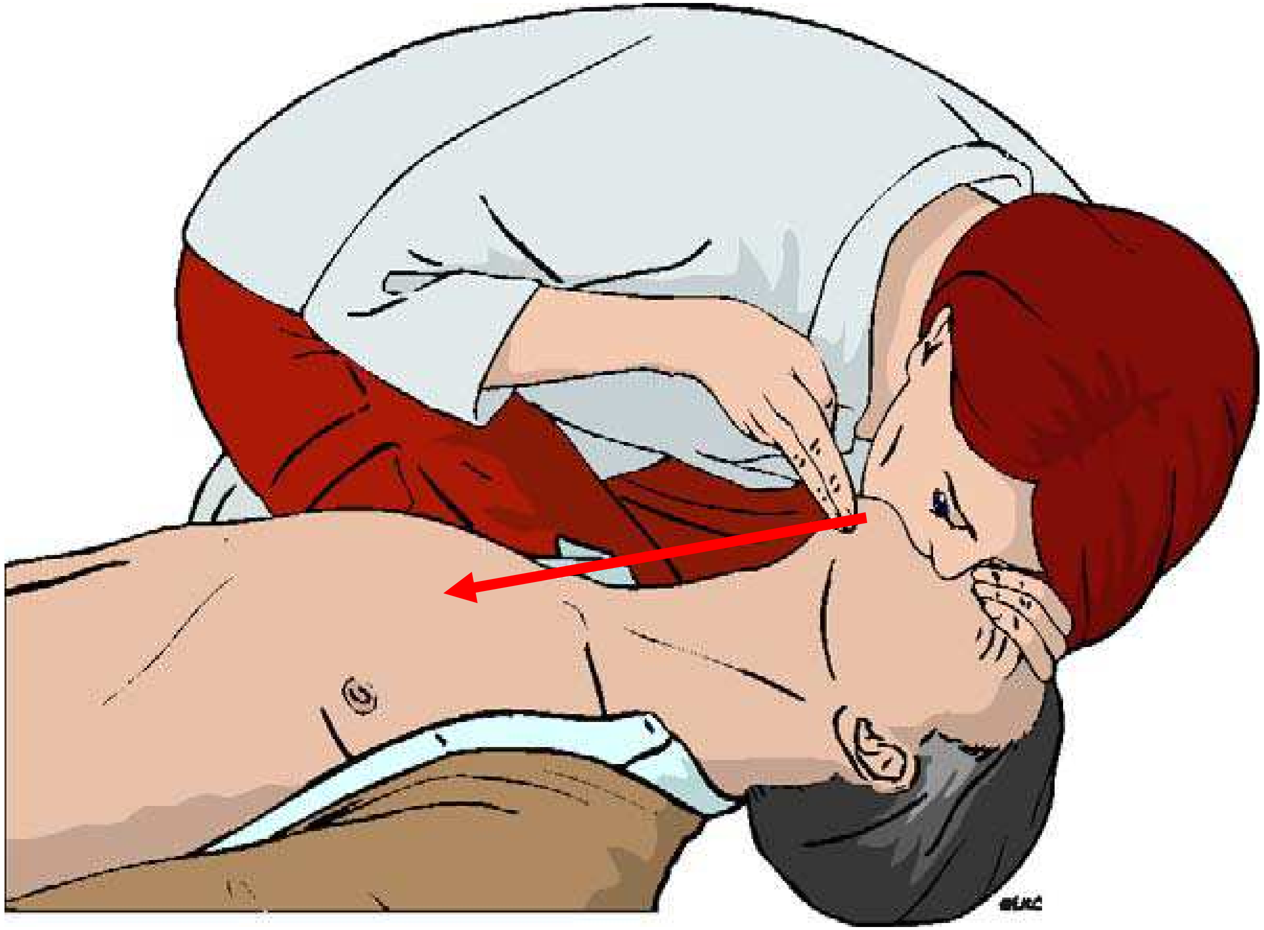


Not breathing normally!

External chest compresion!

To a depth at least 5 cm at a rate 100-120/min!

After 30 compressions – ventilation!



2 rescue breaths in 5 s and then 30 : 2 !

Airways obstruction

- check the mouth
- clear by finger sweep
- check, if head tilt and chin lift performed correctly
- do not attempt more than 2 breaths each time before returning to chest compressions

Compression-only CPR

- **unable rescuers** (laypeople)
  - – EMS dispatcher guided CPR

- **unwilling rescuers** (to provide breathing)

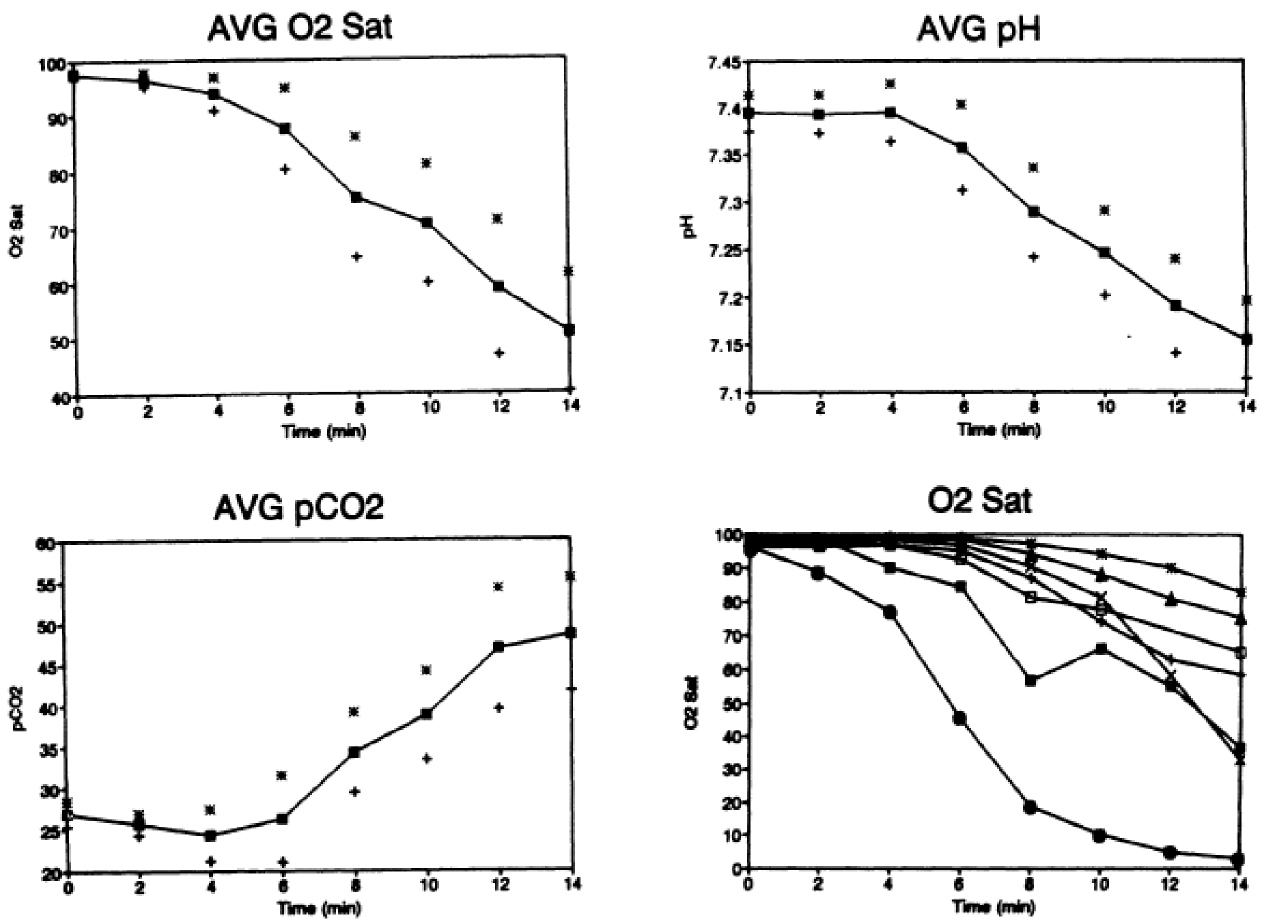
Why compression-only CPR?

- unable rescuers (laypeople)
- unwilling rescuers (to provide breathing)

- occasional gasps and passive chest recoil may provide some air exchange if airways are open (~dead space ventil. 2-4 ml/kg)
- arterial oxygen stores deplete in 2–4 min!
- **in non-asphyxial arrest only!**

Observations of Ventilation During Resuscitation in a Canine Model

Nisha Chibber Chandra, MD; Kreg G. Gruben, PhD; Joshua E. Tsitlik, PhD; Roy Brower, MD; Alan D. Guerci, MD; Henry H. Halperin, MD; Myron L. Weisfeldt, MD; Solbert Permutt, MD



Circulation
1994;90:3070 -3075

Do not interrupt CPR until:

- professional help arrives and takes over
- the victim starts to wake up
  (to move, open eyes, breathes normally)
- till exhaustion

↓

Push hard and fast!

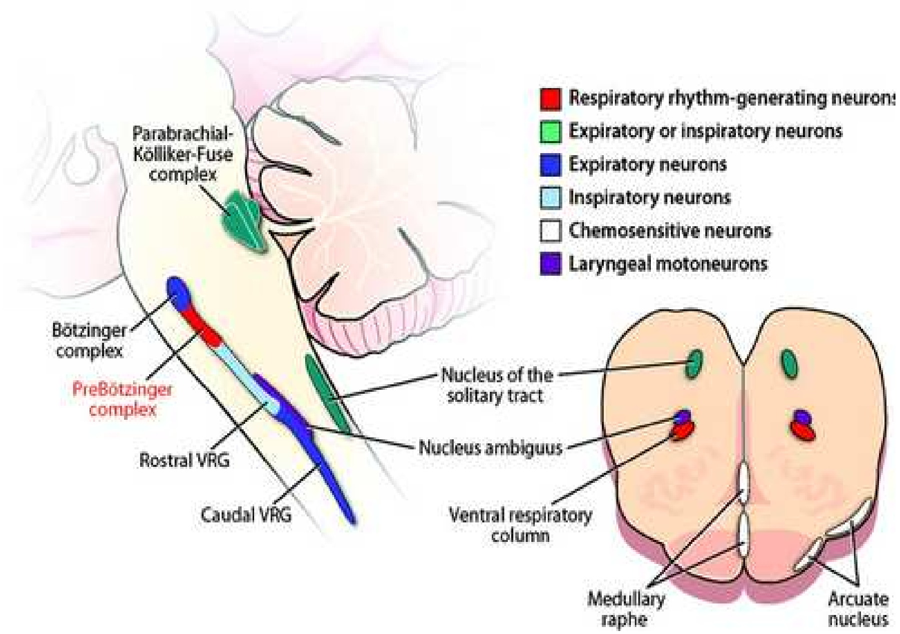
Push hard and fast!

http://youtube.com/watch?v=ILxjxfB4zNk

Agonal breathing

- sudden, strenuous, short inspiration + exspiration and postexspiratory pause, low frequency
- separation between medulla oblongata and pons
  (pre-Bötzinger´s complex and Bötzinger´s complex in VLMO
  and neurons of rostral ventral respiratory group in pons)

- up to 40% cases of CA
- better prognosis
- = indication for CPR



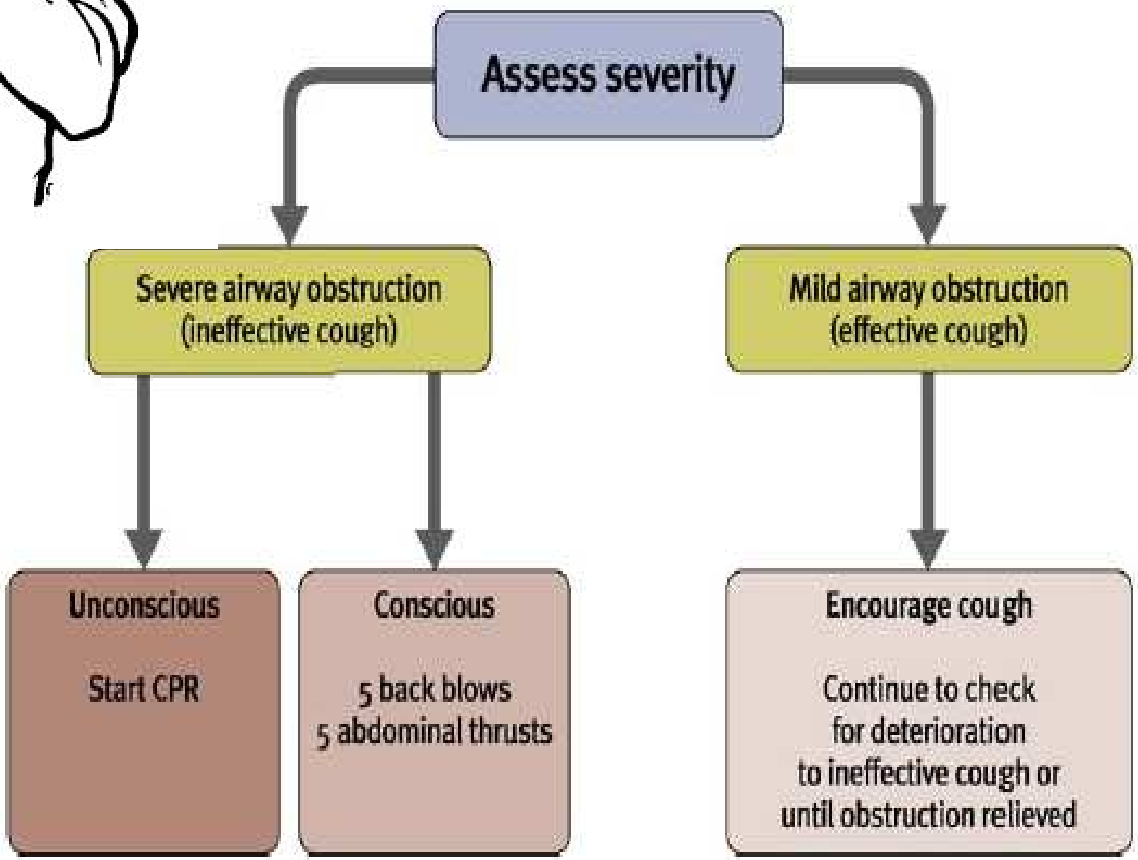
Foreign body airway obstruction

Differentiation between mild and severe foreign body airway obstruction (FBAO).[a]

Sign	Mild obstruction	Severe obstruction
"Are you choking?"	"Yes"	Unable to speak, may nod
Other signs	Can speak, cough, breathe	Cannot breathe/wheezy breathing/silent attempts to cough/unconsciousness

[a] General signs of FBAO: attack occurs while eating; victim may clutch his neck.

Foreign body airway obstruction



Foreign body airway obstruction

- abdominal thrust
- back blows

Best Western Convention Center hotel
38th Street, Manhattan, New York, USA

Breathing during CPR

- lower pulmonary blood flow, thus lower f a V_t
- hyperventilation deleterious
  - higher intrathoracic pressure = lower venous return and CO
  - respiratory alkalosis
- interrupting external chest compressions deleterious!
- risk of gastric distension, regurgitation and aspiration

↓

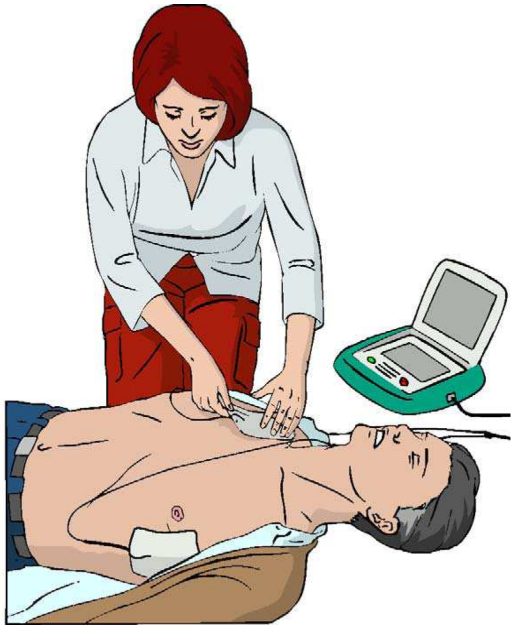
- 2 breaths à 1 s in < 5 s to rise the chest, recommended Vt 6-7 ml/kg, do no hyperventilate!

External chest compressions

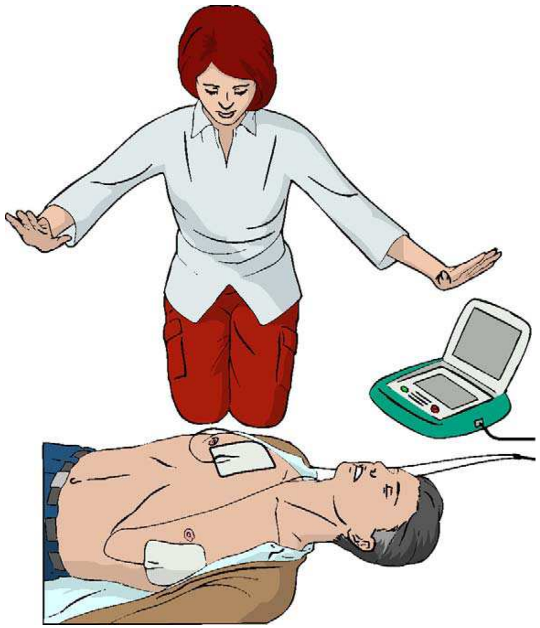
- cardiac pump or chest pump?
- **depth 5-6 cm**
- **frequency 100-120/min** (> 60/min)
- **ratio 30 : 2**
- pressures:
  - systolic 100 mm Hg, diastolic 40 mm Hg,
    mean arterial pressure in carotid aa. < 40 mm Hg
- **firm!, flat! surface**

External chest compressions

Automated external defibrillator



1. Attach pads



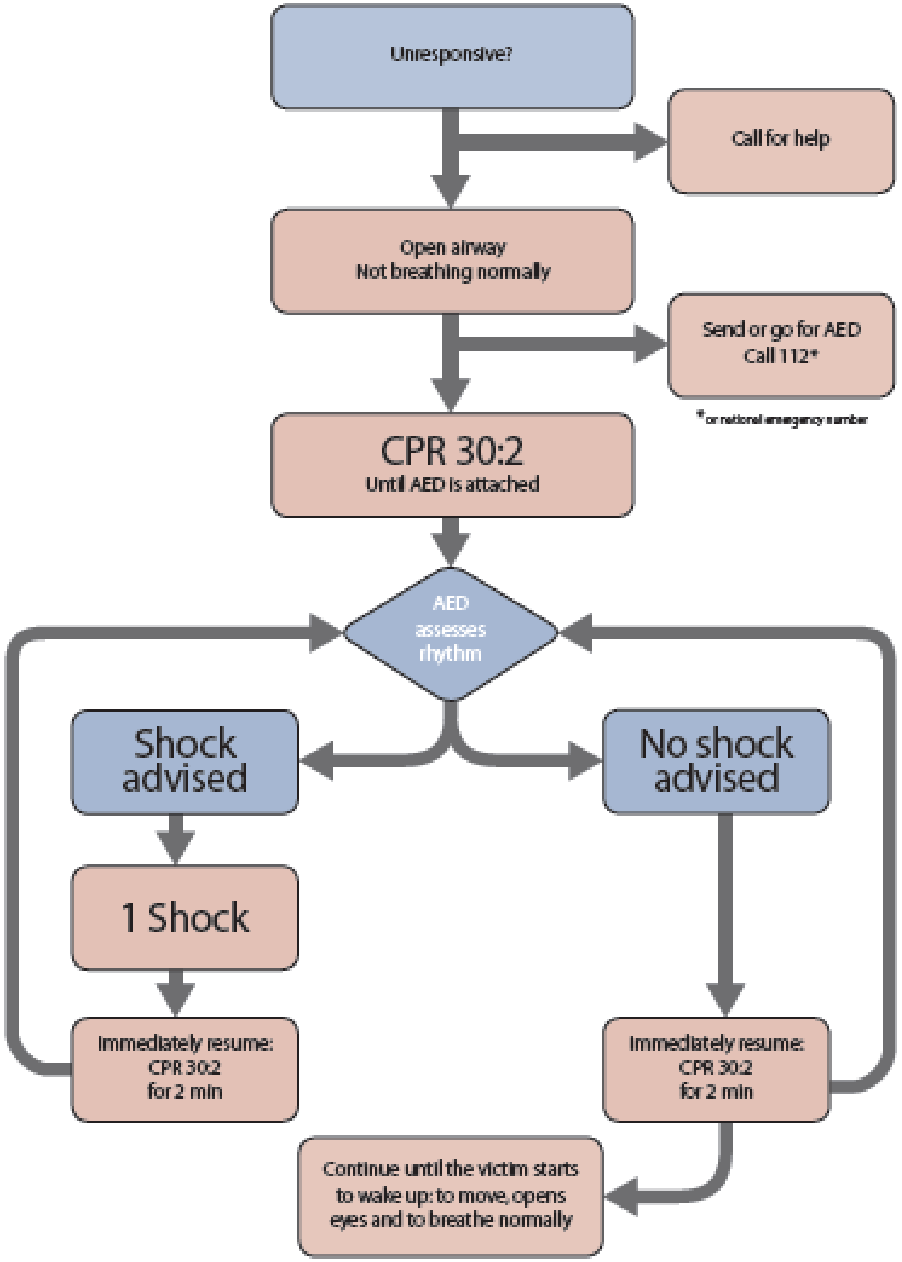
2. Rhythm analysis

3. Continue CPR

4. New rhythm analysis after 2 minutes

Defibrillate in 3 minutes after cardiac arrest optimally!

Automated External Defibrillation



Advanced CPR

Early recognition

- in-hospital cardiac arrest $\rightarrow$ chance for survival 20%
- background:
  - staff education (every 2 years)
  - monitoring of patients
  - recognition of patient deterioration (early warning s.)
  - system to call for help and effictive response
- 62% in-hospital cardiac arrests are preventable!
  Resuscitation, 54 (2002), pp. 115–123

Suppl. 4 Guidelines for perioperative care and system of early warning IOS_5/2009-4

Systém časné identifikace kritických hodnot dospělých

Příznaky

- TK systolický < 100 nebo > 170 mmHg
- TK diastolický < 50 nebo > 100 mmHg
- tepová frekvence > 100/min nebo < 50/min
- SaO_2 < 90% při dýchání vzduchu
- náhlá změna vědomí (kvalitativní, kvantitativní), porucha řeči nebo hybnosti
- diuréza viz
- laboratoř viz
- krvácení do drénů viz

Reakce: 1 příznak → **VOLEJ OŠETŘUJÍCÍHO LÉKAŘE**

2 příznaky → **VOLEJ OŠETŘUJÍCÍHO LÉKAŘE A RESUSCITACI (3333)**

Konzilium lékaře KAR:

A) Ponechání na místě, předpis léčebných opatření, stanovení časového limitu pro kontrolu

B) Překlad na RES

Kontrola lékařem KAR ve stanoveném časovém limitu:

A) Účinek léčebných opatření → příznivý → ponechat na místě

B) Účinek léčebných opatření → nedostatečný → překlad na RES

Vědomí

Volat vždy ošetřujícího lékaře:

- náhlá změna vědomí, porucha řeči nebo hybnosti
  - kvalitativní - náhlý neklid, zmatenost, agrese
  - kvantitativní - pacient náhle neodpovídá na výzvu

Dýchání

Hodnocení dechové frekvence

	Dospělý	Dítě nad 12 let
bradypnoe	< 10 dechů/min	< 10 dechů/min
tachypnoe	> 25 dechů/min	> 25 dechů/min

	Dítě 3 - 12 let	Dítě 1 - 3 roky
bradypnoe	< 12 dechů/min	< 15 dechů/min
tachypnoe	> 25 dechů/min	> 30 dechů/min

	Kojenec	Novorozenec
bradypnoe	< 20 dechů/min	< 20 dechů/min
tachypnoe	> 40 dechů/min	> 60 dechů/min

Volat vždy ošetřujícího lékaře:

- pokles SaO_2 pod 90% nebo o více než 10% hodnoty, kterou naposledy schválil lékař
- bradypnoe/tachypnoe viz tabulky, neordinuje-li OL jinak
- náhle vzniklá změna dýchacích pohybů

Guidelines for perioperative care and system of early warning IIOS_5/2009-4

Oběh

Hodnocení tepové frekvence

	Dospělý
bradykardie	< 50/min
tachykardie	> 100/min

Volat vždy ošetřujícího lékaře:

- je-li tepová frekvence mimo uvedené meze a nestanoví-li OL jinak

Hodnocení krevního tlaku [mmHg]

	Dospělý
hypotenze	< 100 mmHg v systole nebo < 50 mmHg v diastole
hypertenze	> 170 mmHg v systole nebo > 100 mmHg v diastole

Volat vždy ošetřujícího lékaře:

- je-li hodnota TK mimo uvedené meze a nestanoví-li OL jinak

	Rozmezí fyziologických hodnot tepové frekvence [P/min]	Fyziologické hodnoty krevního tlaku [mmHg] systolický	Fyziologické hodnoty krevního tlaku [mmHg] diastolický
nedonošenci	120 - 170	55 - 75	35 - 45
0 - 3 měsíce	100 - 150	65 - 85	45 - 55
3 - 6 měsíců	90 - 120	70 - 90	50 - 65
6 - 12 měsíců	80 - 120	80 - 100	55 - 65
1 - 3 roky	70 - 110	90 - 105	55 - 70
3 - 6 let	65 - 110	95 - 110	60 - 75
6 - 12 let	60 - 95	100 - 120	60 - 75
nad 12 let	55 - 85	110 - 135	65 - 85

Volat vždy ošetřujícího lékaře:

- je-li tepová frekvence, TK nebo obojí mimo uvedené meze a nestanoví-li OL jinak

Diuréza

Volat vždy ošetřujícího lékaře:

- nově vzniklá hematurie
- pokles diurézy pod 0,5 ml/kg/hod za poslední 3 hodiny, neordinuje-li OL jinak

Krvácení do drénů

Volat vždy ošetřujícího lékaře:

- náhlé krvácení - definuje operační obor
- pokračující krvácení - definuje operační obor

Laboratoř

K^+ > 6,5 mmol/l

INR > 5

Glykémie < 4 mmol/l

Volat vždy ošetřujícího lékaře:

- je-li hodnota výsledku vyšetření mimo uvedené meze a nestanoví-li OL jinak

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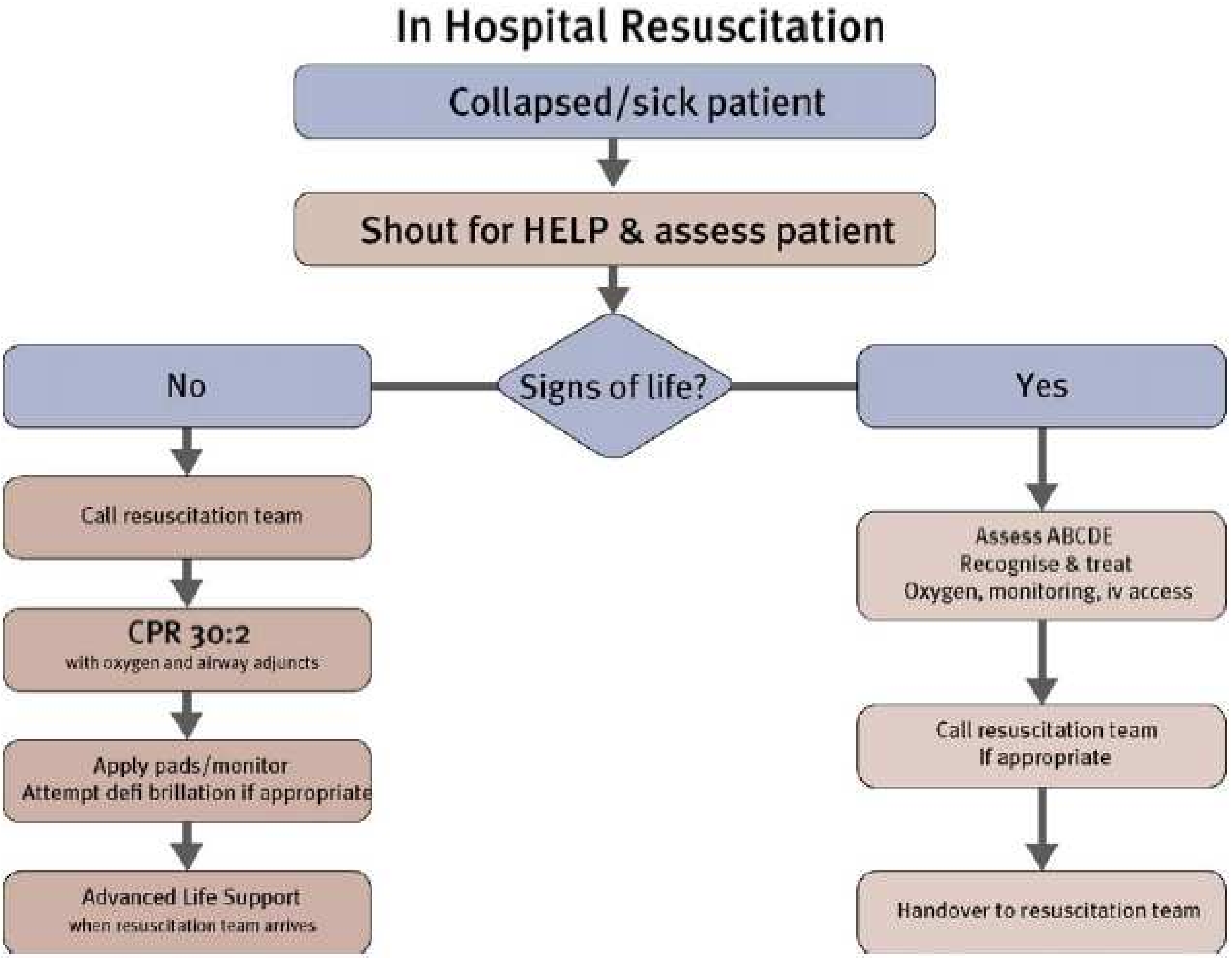
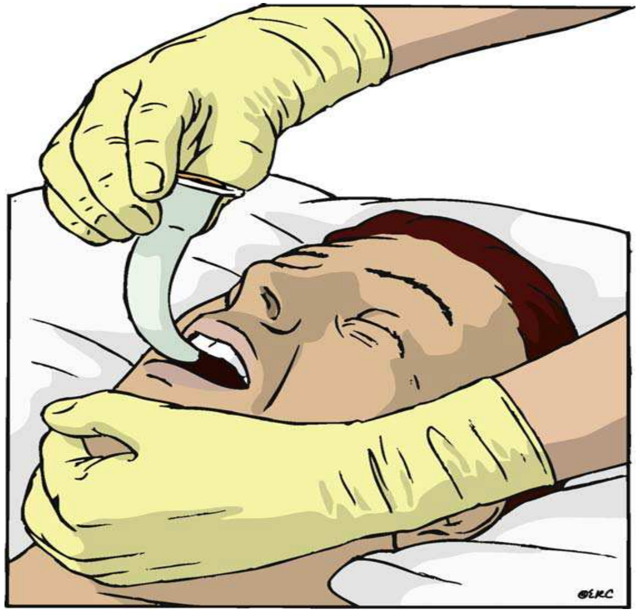
V Úvalu 84, 150 06 Praha 5

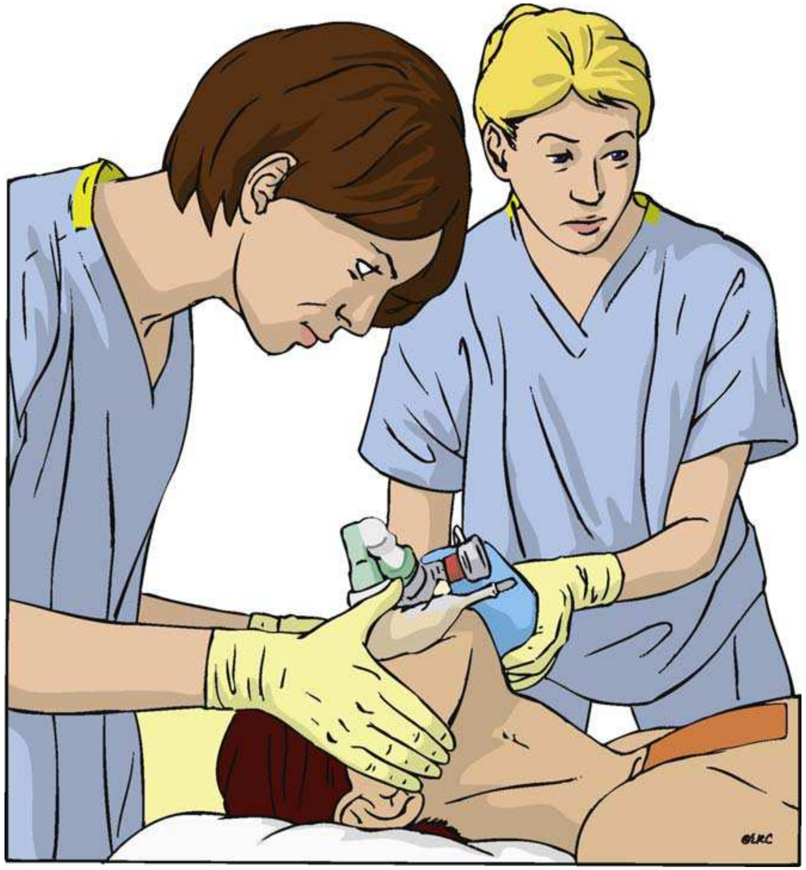
FN MOTOL


In Hospital Resuscitation
Collapsed/sick patient
Shout for HELP & assess patient
Signs of life?
No
Yes
Call resuscitation team
CPR 30:2
with oxygen and airway adjuncts
Apply pads/monitor
Attempt defi brillation if appropriate
Advanced Life Support
when resuscitation team arrives
Assess ABCDE
Recognise & treat
Oxygen, monitoring, iv access
Call resuscitation team
if appropriate
Handover to resuscitation team

Airway management with adjuncts

- jaw thrust = triple (Esmarch´s) maneuvre
  head tilt + chin lift + mouth opening
- oropharyngeal and naso-pharyngeal airways
- bag-mask ventilation





Jaw thrust

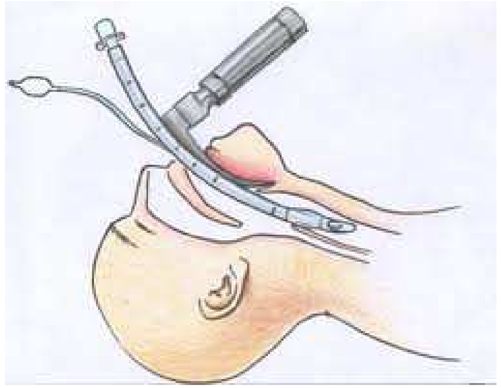
Triple (Esmarch´s) maneuvre

head tilt + chin lift + mouth opening

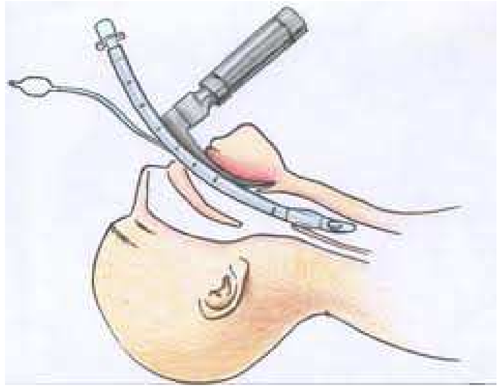
Johann Friedrich August von Esmarch (1823-1908)

Airway management

- intubation – the gold standard
  - during uninterrupted ECC
  - interruption for tube insertion < 10 s
  - normo-ventilation 10 breaths/min!



Airway management



- intubation – the gold standard
  - during uninterrupted ECC
  - Interruption for tube insertion < 10 s
  - normo-ventilation 10 breaths/min!
- supraglottic devices, if lack of experience
  - oral and nasal airways
  - laryngeal mask
  - I-gel
  - Combitube aj.

Clinical paper

Endotracheal intubation versus supraglottic airway insertion in out-of-hospital cardiac arrest☆

Henry E. Wang[a,*], Daniel Szydlo[b], John A. Stouffer[c], Steve Lin[d,e], Jestin N. Carlson[f], Christian Vaillancourt[g], Gena Sears[b], Richard P. Verbeek[e], Raymond Fowler[h], Ahamed H. Idris[h], Karl Koenig[i], James Christenson[j], Anushirvan Minokadeh[k], Joseph Brandt[l], Thomas Rea[m,n], The ROC Investigators

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ABSTRACT

Objective: To simplify airway management and minimize cardiopulmonary resuscitation (CPR) chest compression interruptions, some emergency medical services (EMS) practitioners utilize supraglottic airway (SGA) devices instead of endotracheal intubation (ETI) as the primary airway adjunct in out-of-hospital cardiac arrest (OHCA). We compared the outcomes of patients receiving ETI with those receiving SGA following OHCA.

Methods: We performed a secondary analysis of data from the multicenter Resuscitation Outcomes Consortium (ROC) PRIMED trial. We studied adult non-traumatic OHCA receiving successful SGA insertion (King Laryngeal Tube, Combitube, and Laryngeal Mask Airway) or successful ETI. The primary outcome was survival to hospital discharge with satisfactory functional status (Modified Rankin Scale ≤3). Secondary outcomes included return of spontaneous circulation (ROSC), 24-h survival, major airway or pulmonary complications (pulmonary edema, internal thoracic or abdominal injuries, acute lung injury, sepsis, and pneumonia). Using multivariable logistic regression, we studied the association between out-of-hospital airway management method (ETI vs. SGA) and OHCA outcomes, adjusting for confounders.

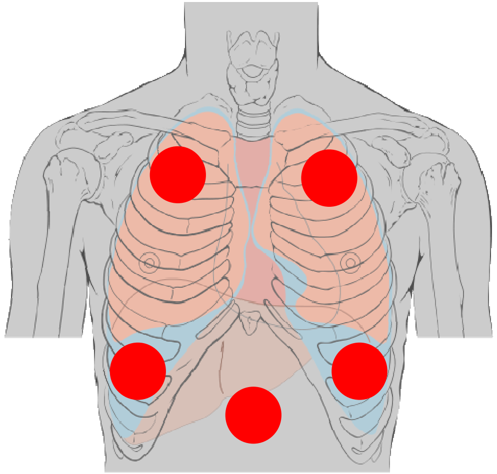
Results: Of 10,455 adult OHCA, 8487 (81.2%) received ETI and 1968 (18.8%) received SGA. Survival to hospital discharge with satisfactory functional status was: ETI 4.7%, SGA 3.9%. Compared with successful SGA, successful ETI was associated with increased survival to hospital discharge (adjusted OR 1.40; 95% CI: 1.04, 1.89), ROSC (adjusted OR 1.78; 95% CI: 1.54, 2.04) and 24-h survival (adjusted OR 1.74; 95% CI: 1.49, 2.04). ETI was not associated with secondary airway or pulmonary complications (adjusted OR 0.84; 95% CI: 0.61, 1.16).

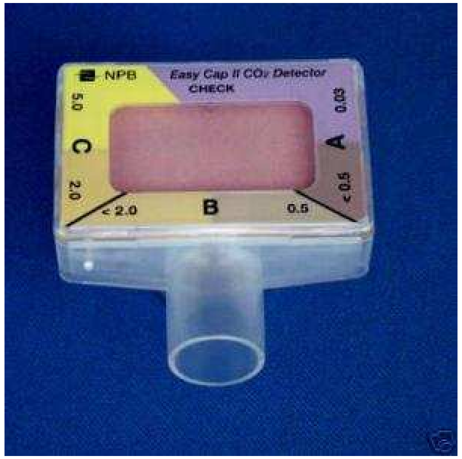
Conclusions: In this secondary analysis of data from the multicenter ROC PRIMED trial, ETI was associated with improved outcomes over SGA insertion after OHCA.

This study clearly shows in more than 10000 patients, than endotracheal intubation is the best way of airway management during CPR, crucial because this is a key skill of the anaesthesiologist. Patients receiving endotracheal intubation out of hospital have a 40% higher survival rate compared to those receiving other forms of airway management.

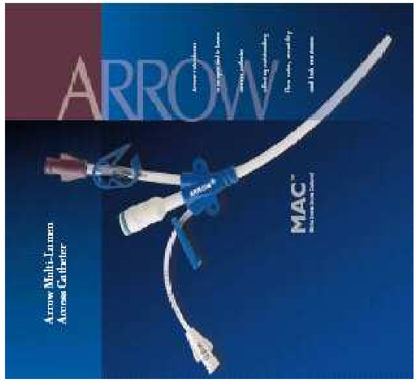
How to confirm the correct placement of the tube

- look
  - chest is rising symetrically!
- listen
  - over the lungs
  - over the stomach!
- feel
  - chest is rising symetrically!
  - air escapes from the tube if chest is compressed
- capnometry
- ultrasound





Venous access



- peripheral vein, if not already secured
- administer the drug, then flush with > 20 ml fluid and/or rise the extremity for 10-20 s

- central venous access is better, but:
  - needs interrupting of CPR, thus not indicated
- alternative approaches:
  - bone marrow
  - intratracheally unreliable, not recommended now!

Hagen-Poiseuille´s law

$$Q = \frac{\pi R^4}{8\mu . l}\left(-\frac{dp}{dx}\right)$$

Q = flow, R = tube diameter, μ = viscosity,
l = lenght of the tube,dp/dx = pressure change along the tube

Hagen-Poiseuille´s law in practice

Gauge	Flow
24 G	18
22 G	36
20 G	55
18 G	105
16 G	215
14 G	330
	ml/min

Precordial thump

- indicated in the first seconds of shockable rhythm, especially in pulseless ventricular tachycardia
- efficiency low

Mechanical chest compression

- LUCAS (Lund University Cardiac Arrest System)
- AutoPulse

Drugs for CPR

- **adrenaline** no evidence, but recommended
- **amiodarone**, 2. choice **lido-/mesocaine** dtto
- **atropine** not recommended for routine use in asystoly/PEA

- **potassium, magnesium** torsade de pointes

- **calcium** not routinely
- **bicarbonate** not routinely

Adrenaline = epinephrine

- insufficient evidence, but recommended
- **alfa-adrenergic eff**. → vasoconstriction → pressure increase (CPP, CoPP) → coarse fibrillation = better chance for defi + ROSC
- disturbs microcirculation and leads to heart dysfunction after ROSC
- pharmacokinetics in CPR unknown, dose?
- **in all types of cardiac arrest**

  after the 3^{rd} defi, 0.01 mg/kg, every 3-5 min
- **anaphylaxis**

Clinical Paper

Outcome when adrenaline (epinephrine) was actually given vs. not given – post hoc analysis of a randomized clinical trial☆

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ABSTRACT

Purpose of the study: IV line insertion and drugs did not affect long-term survival in an out-of-hospital cardiac arrest (OHCA) randomized clinical trial (RCT). In a previous large registry study adrenaline was negatively associated with survival from OHCA. The present post hoc analysis on the RCT data compares outcomes for patients actually receiving adrenaline to those not receiving adrenaline.
Materials and methods: : Patients from a RCT performed May 2003 to April 2008 were included. Three patients from the original intention-to-treat analysis were excluded due to insufficient documentation of adrenaline administration. Quality of cardiopulmonary resuscitation (CPR) and clinical outcomes were compared.
Results: Clinical characteristics were similar and CPR quality comparable and within guideline recommendations for 367 patients receiving adrenaline and 481 patients not receiving adrenaline. Odds ratio (OR) for being admitted to hospital, being discharged from hospital and surviving with favourable neurological outcome for the adrenaline vs. no-adrenaline group was 2.5 (CI 1.9, 3.4), 0.5 (CI 0.3, 0.8) and 0.4 (CI 0.2, 0.7), respectively. Ventricular fibrillation, response interval, witnessed arrest, gender, age and endotracheal intubation were confounders in multivariate logistic regression analysis. OR for survival for adrenaline vs. no-adrenaline adjusted for confounders was 0.52 (95% CI: 0.29, 0.92).
Conclusion: Receiving adrenaline was associated with improved short-term survival, but decreased survival to hospital discharge and survival with favourable neurological outcome after OHCA. This post hoc survival analysis is in contrast to the previous intention-to-treat analysis of the same data, but agrees with previous non-randomized registry data. This shows limitations of non-randomized or non-intention-to-treat analyses.

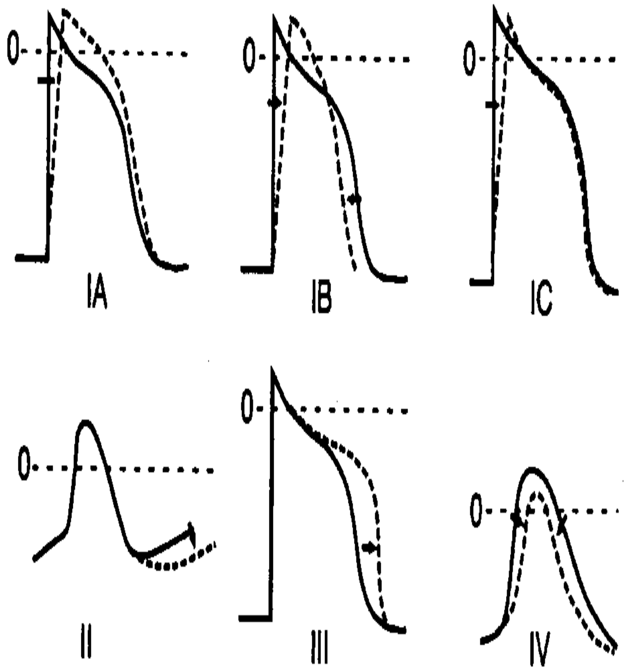
Antiarrhythmics

- no evidence, that antiarrhythmics in CPR increase survival to hospital discharge
- amiodarone
  - indicated, in VT/VF after the 3rd shock
  - 300 mg i.v., ev. + 150 mg, inf. 900 mg/24 h
- lidocaine (trimecaine)
  - 1 mg/kg i.v. in amiodarone unavailable

Antiarrhythmics

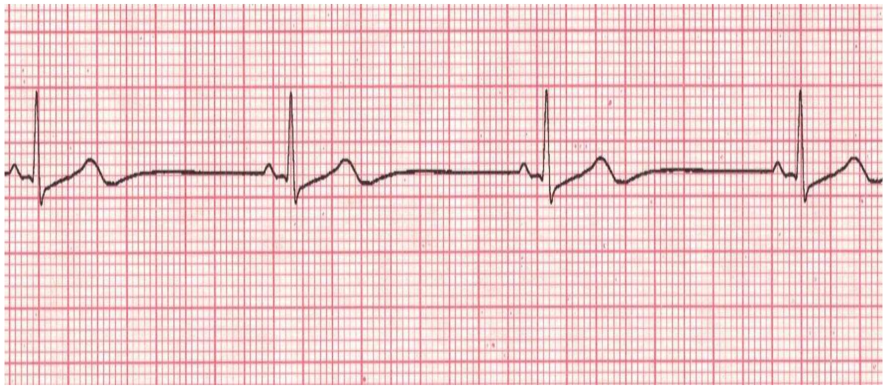
Vaughan-Williams electrophysiological classification 1984

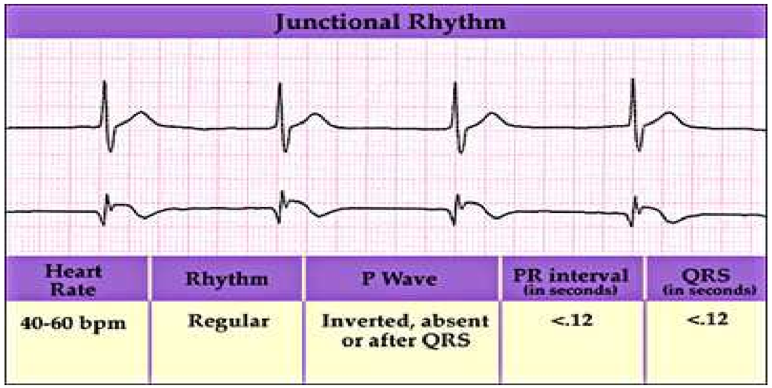
- I sodium channel blockers
  - Ia chinidine, prokainamide, ajmaline
  - Ib lidocaine, mexiletine, phenytoine
  - Ic encainide, flecainide, propafenon
- II   beta-blockers
- III   potassium channel blockers
  prolongation of repolarization
  - **amiodarone etc.**
- IV   verapamil, dilthiazem
- other – digoxine, adenosine



Atropine

- acetylcholine antagonist
  at muscarinic synapses of Psy
- increase SA automaticity a AV node conduction
- indication:
  - sinus, atrial, nodal **bradycardia with hemodynamic instability** (hypotension, arrhythmia, ischemia)





- routine use in asystoly/PEA **not recommended!**

Bicarbonate

- routine administration during CPR and after ROSC not recommended
- indication: (50 mmol = 50 ml 8.4% solution)
  - according to acid-base distarbances
  - hyperkalemia
  - tricyclic antidepressants intoxication

Calcium

- no evidence, more likely harmful
- indication:
  - hyperkalemia
  - hypocalcemia
  - calcium channel blockers intoxication

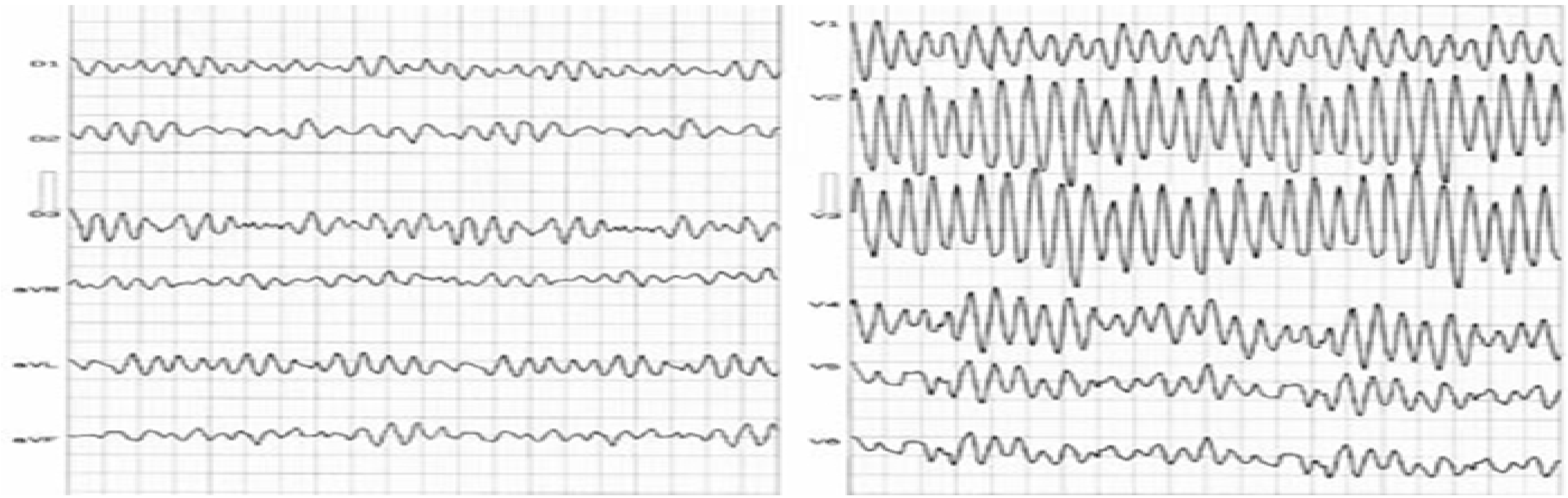
Magnesium

- no evidence

- main indication in torsade de pointes
  (= ventricular tachycardia characterised by periodical twisting of QRS complexes and frequency 200-250/min)
- in SVT with hypomagnesemia, hypokalemia
- in digoxin toxicity
- dose 2 g i.v. = 10 ml 20% $MgSO_4$

ECG patterns of cardiac arrest

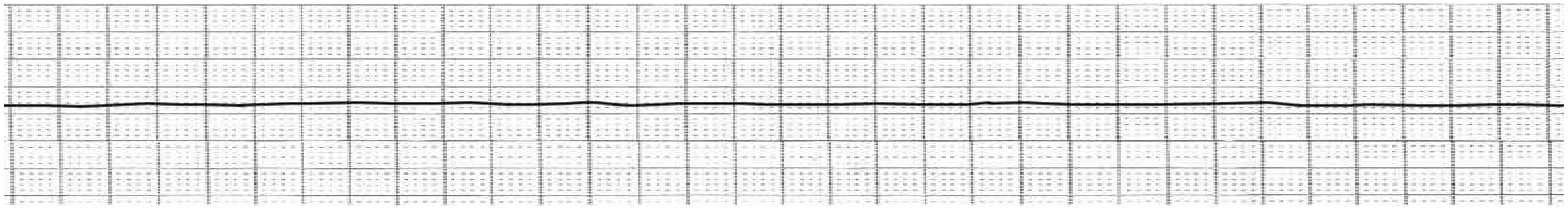
- shockable
  - ventricular tachycardia
  - fibrillation (coarse x fine)



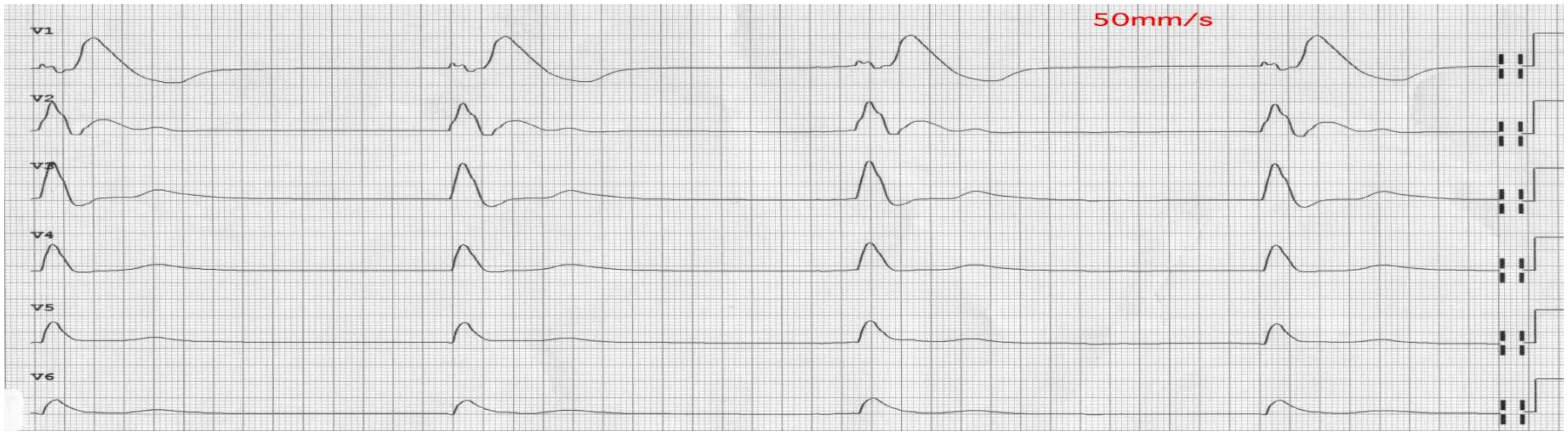
  - torsade de pointes

ECG patterns of cardiac arrest

- non-shockable
  - asystoly

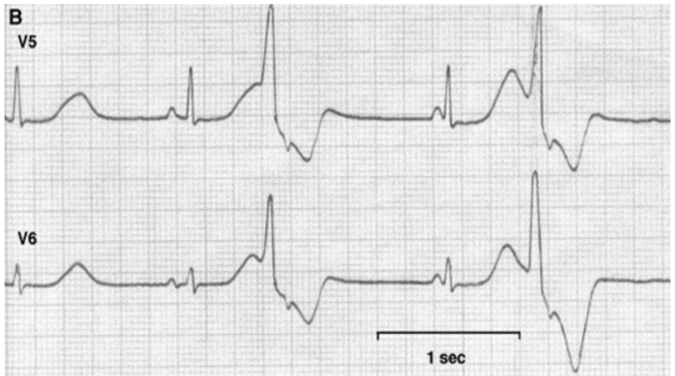


  - pulseless electrical acitivity (PEA) – electrical activity, which would be normally connected with pulse, often recognizable cause (4Hs + 4Ts)



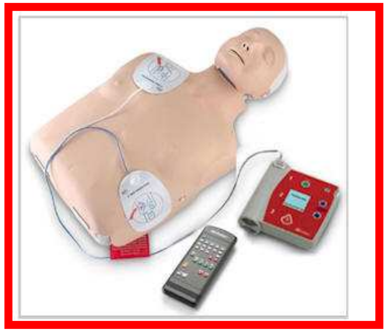
Electrotherapy

- **defibrillation** = passage of an electrical current of sufficient magnitude across the myocardium to depolarise a critical mass of myocardium and enable restoration of coordinated electrical activity.
- **cardioversion** = interruption of atrial/ventricular tachycardia by passage of an electrical current
  - synchronized with R (better)
  - unsynchronized



Defibrillation

- electrodes: ø 8-12 cm, 150 cm^2, children < 8 years
  - pads self-adhesive
  - paddles

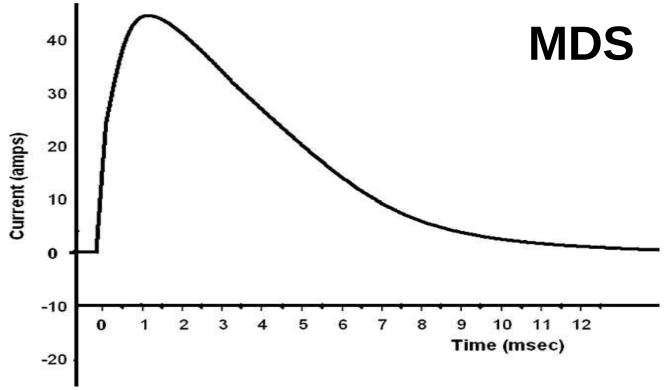


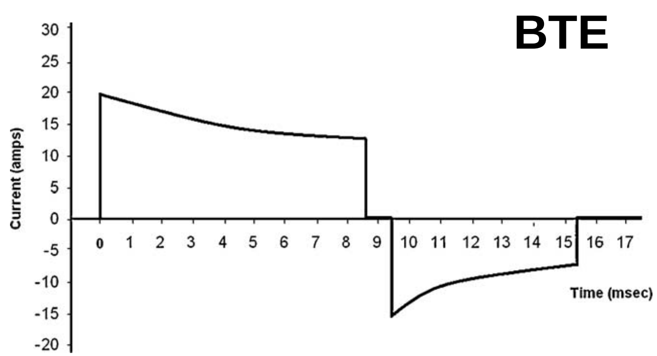
- electrode position
  - traditional: right parasternally – heart apex, 6^{th} intercostal sp.
  - bi-axillary (on lateral chest walls)
  - right upper back – heart apex
  - antero-posterior (heart apex – below the left scapula)
- conductive gel to decrease the resistance (70-80 ohm)
- paddle force 3 - 5 - 8 kp newborn, children, adults)
- shock during exspiration

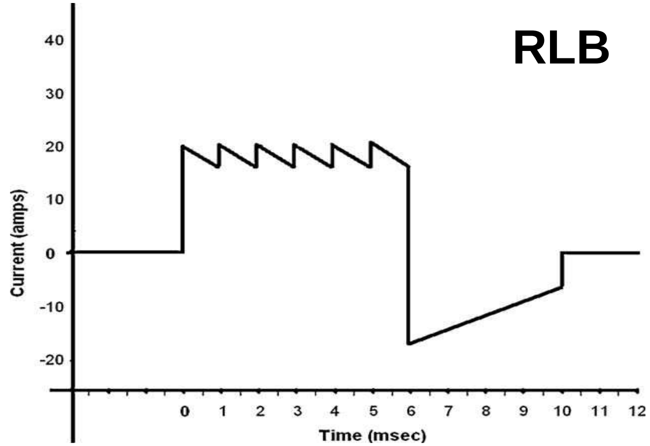
Defibrillation

- waveforms:
  - monophasic damped sinusoidal (30-40 A, tj. 200-360 J)
  - biphasic (15-20 A, tj. 150 J)
    - truncated exponential
    - rectilineal
  - multiphasic (expriment)
- energy level: optimal?

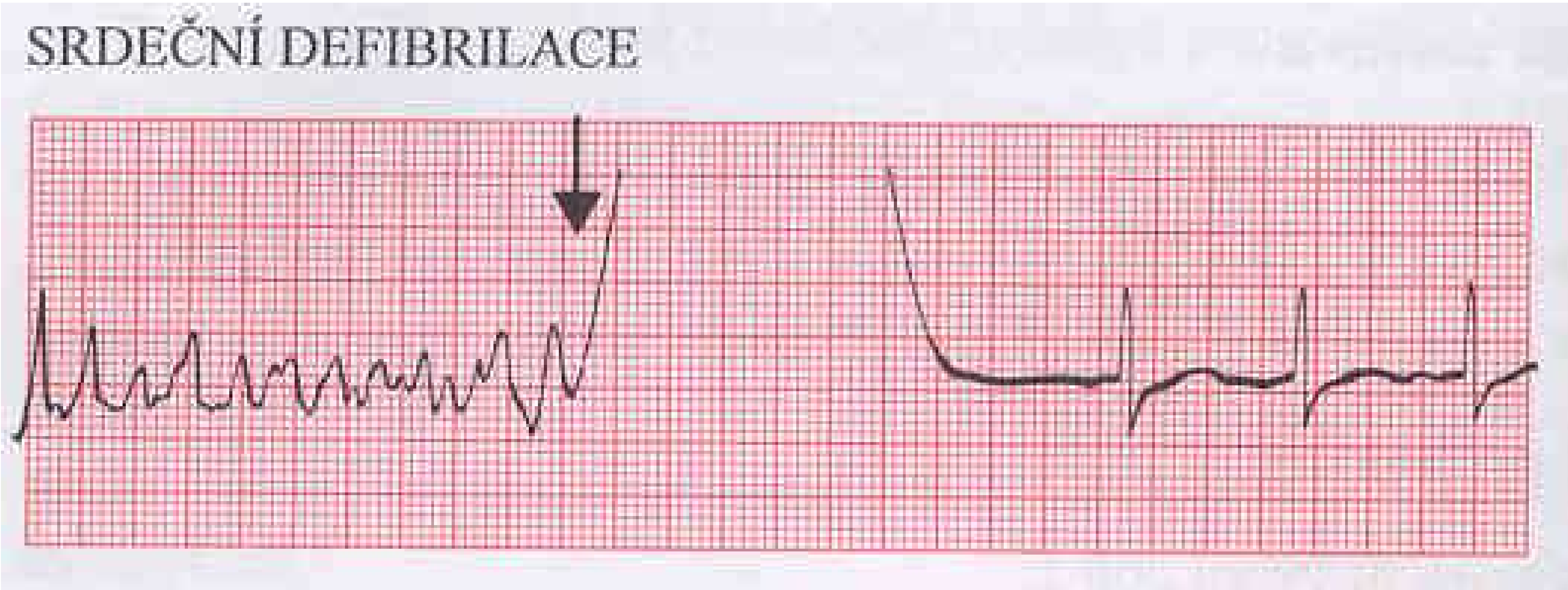
  achieves defibrillation whilst causing the minimum of myocardial damage



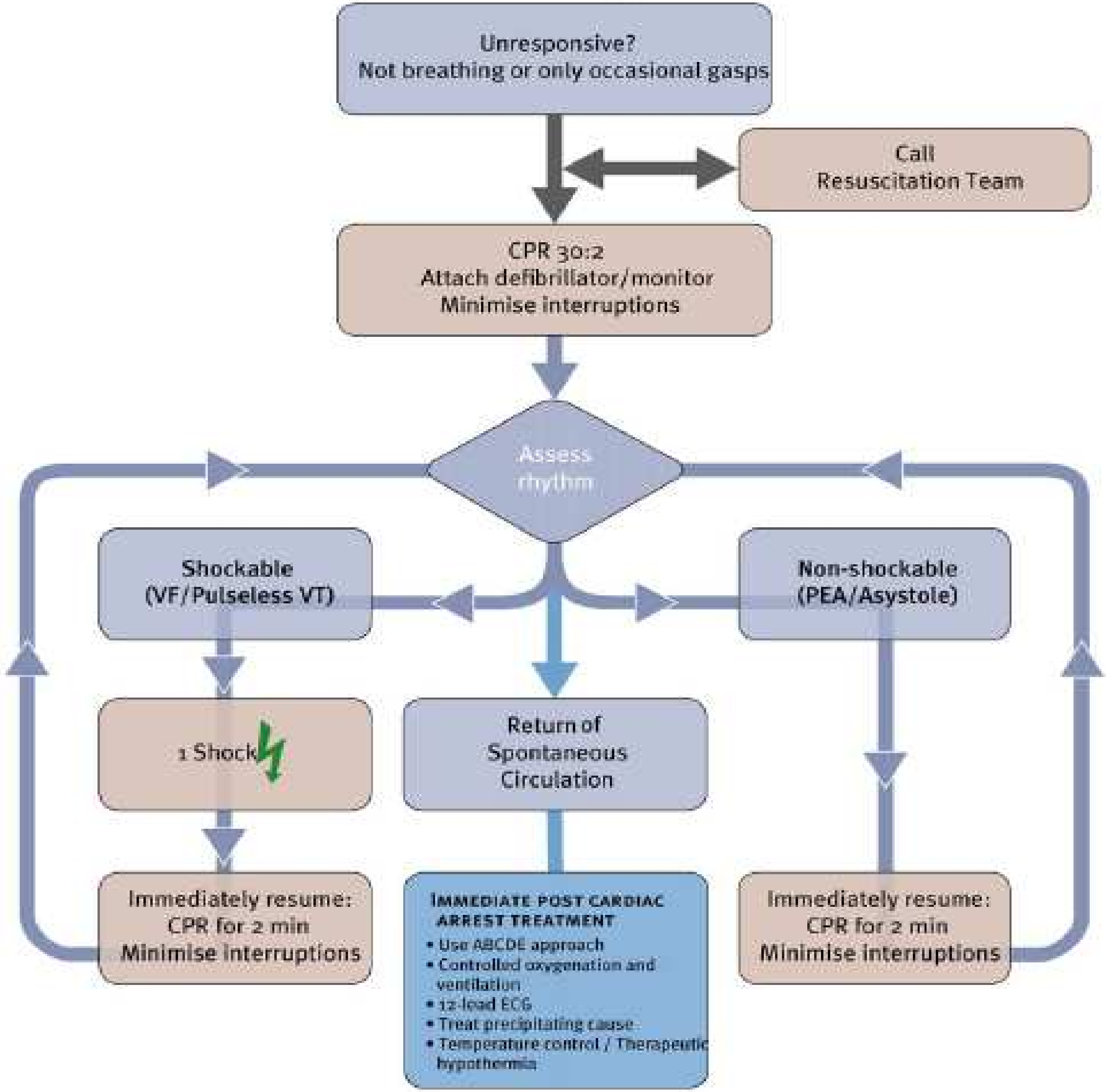




Defibrillation



Advanced Life Support



Summary of advanced CPR

During CPR

- Ensure high-quality CPR: rate, depth, recoil
- Plan actions before interrupting CPR
- Give oxygen
- Consider advanced airway and capnography
- Continuous chest compressions when advanced airway in place
- Vascular access (intravenous, intraosseous)
- Give adrenaline every 3-5 min
- Correct reversible causes

Reversible causes

- Hypoxia
- Hypovolaemia
- Hypo-/hyperkalaemia/metabolic
- Hypothermia

- Thrombosis - coronary or pulmonary
- Tamponade - cardiac
- Toxins
- Tension pneumothorax

Tachycardia Algorithm (with pulse)

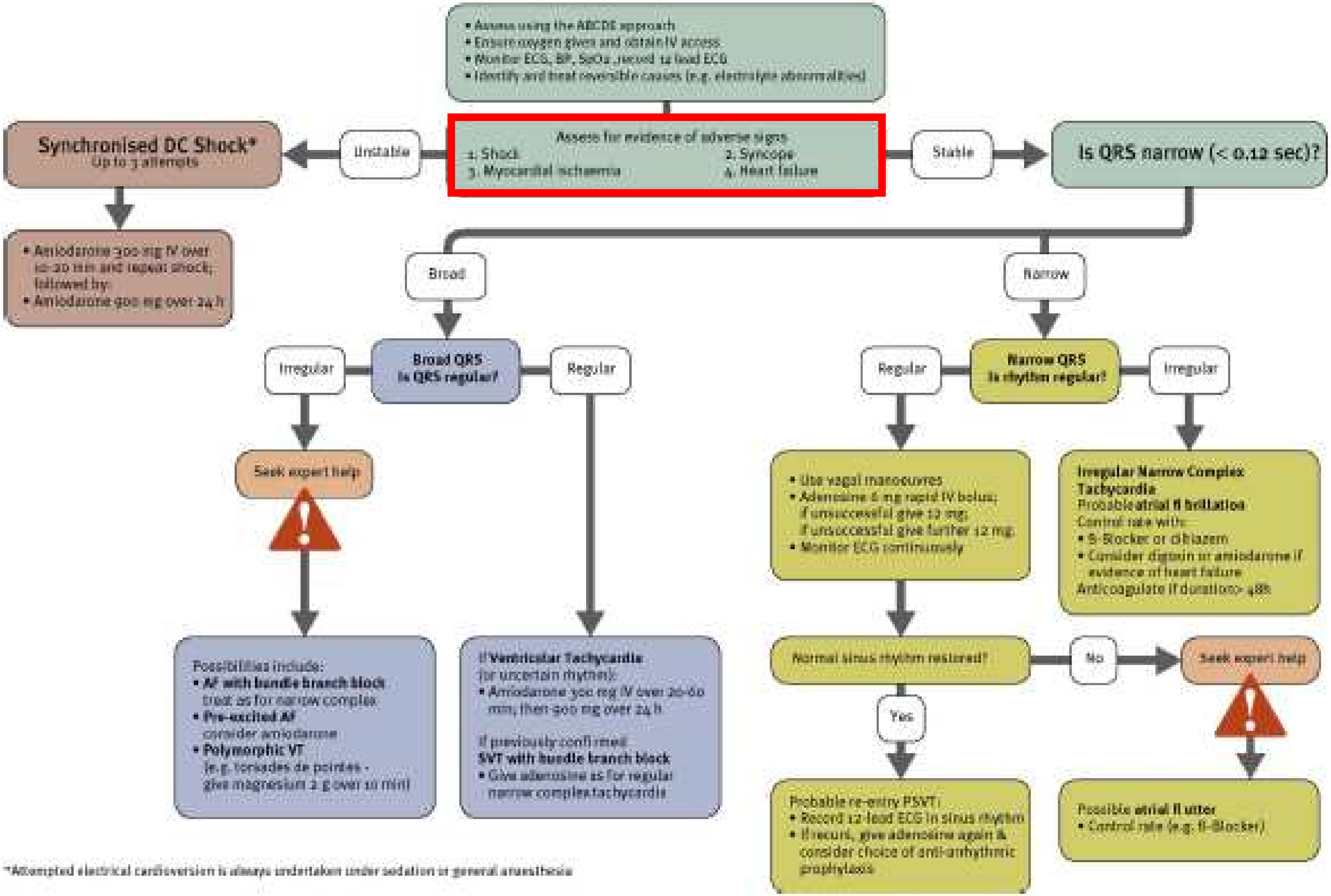
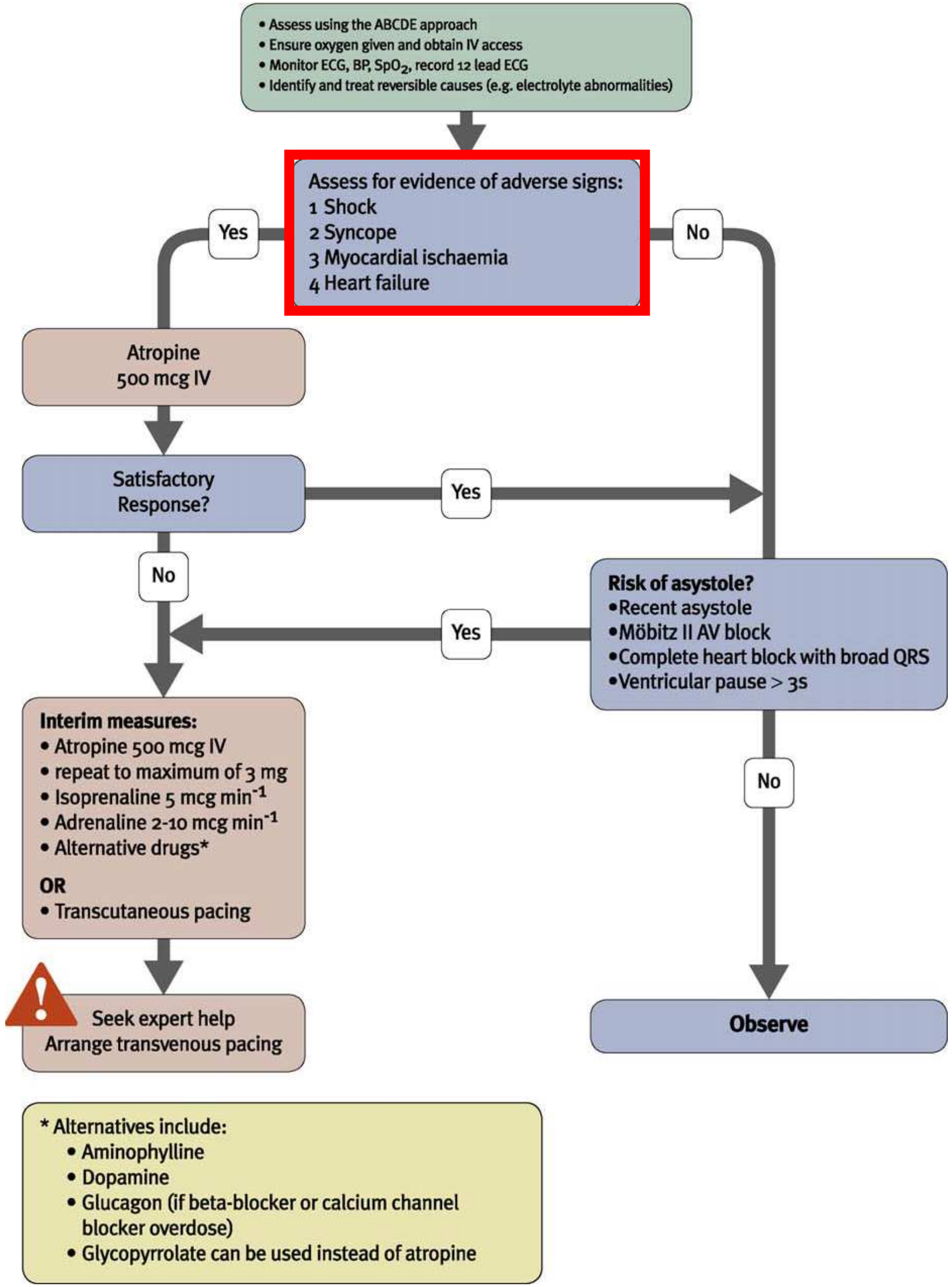


Fig.4.11. Tachycardia algorithm, © 2010 ERC.

Bradycardia Algorithm



Complications of CPR

- gastric distension, aspiration
- fractures: ribs, sternum
- injury: oesophagus, liver, spleen, bleeding into cavities, pneumothorax
- arrhythmias, circulatory instability
- after ROSC: post-cardiac arrest sy:
  - brain dysfunction, posthypoxic brain oedema
  - heart dysfunction, heart failure
  - ischemic-reperfusion injury
  - multiorgan failure

Post-resuscitation care

Post-resuscitation care

= good complex intensive care

- **A**irways:
- **B**reathing:
  - avoid hypo-/hyper –oxemia and –capnia (94-96% SaO_2)
- **C**irculation:
  - target MAP to achieve diuresis 1 ml/kg/h
  - consider coronary angiography and echocardiography

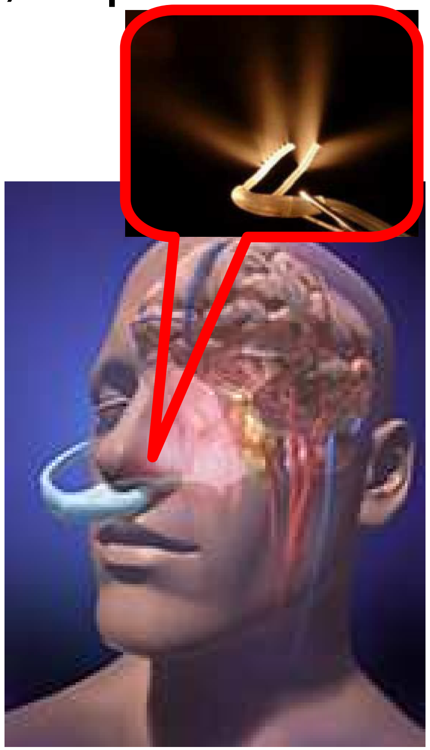
Post-resuscitation care
= good complex intensive care

- **D**isability:
  - sedation?
  - control of seizures and myoclonus (↑ brain mtb 3x)
    - benzodiazepines, propofol, barbiturates
    - clonazepam
  - glucose control (avoid hypoglycemia, ≤10mmol/l)
  - temperature control (avoid hyperthermia)

- **G**auging
  - cause of the arrest
  - neurological recovery

Therapeutic hypothermia

- 32-34 ^{o}C, usually during 4 h for 12-24 h
- induction, maintenance, rewarming 0.5 ^{o}C/h
- indication:
  - coma after CPR from non-traumatic origin, esp. VF
  - functional circulation
- methods:
  - cold infusion
    (4 ^{o}C, 30 ml/kg i.v. - RIVA)
  - intranasal evaporative cooling
  - blankets, ice packs
  - i.v. heat exchanger,
    extracorp. circulation



Differences of CPR in children

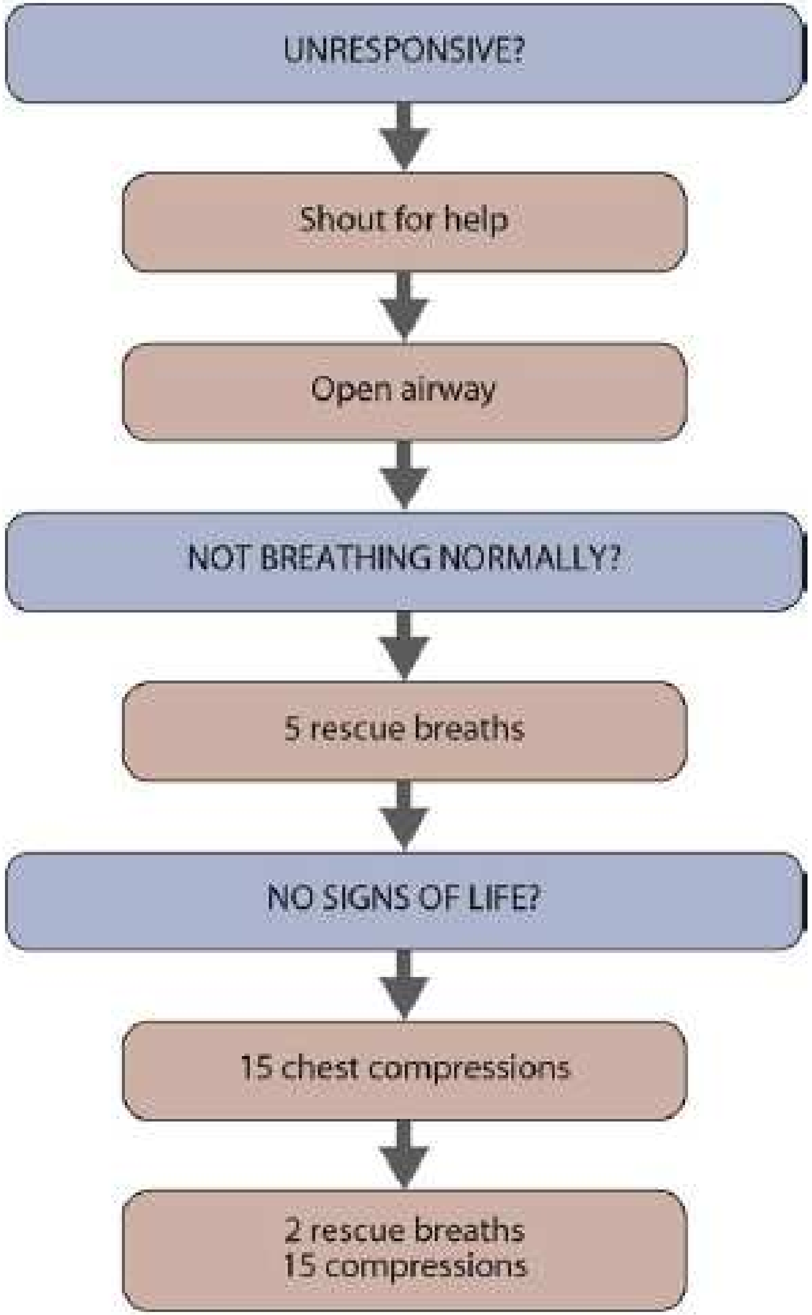
Terminology:

- newly born: immediately after delivery
- newborn: ≤ 4 týdny
- infant ≤ 1 year
- child ≤ puberty → guidelines for children
- adolescent ≥ puberty → gdlns for adults

Child is not a small adult!

- different causes of cardiac arrest prompt a little bit different treatment

Paediatric basic life support



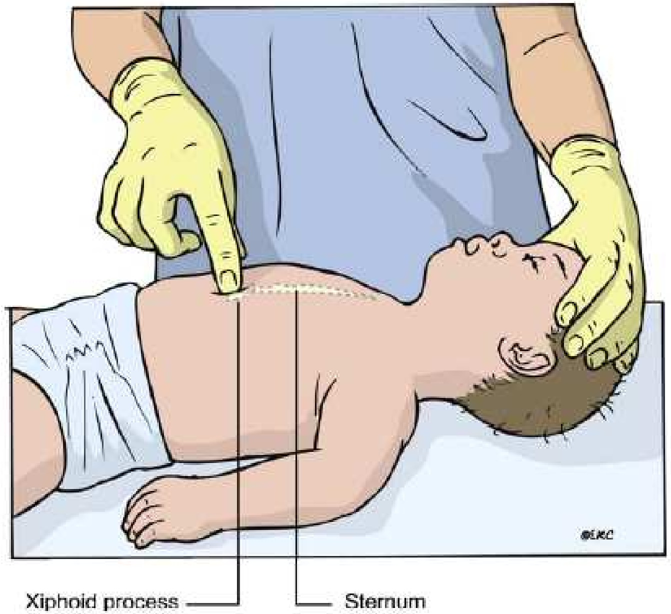
Differences of CPR in children

- **experienced rescuer:**
  - pulse check (brachial artery, or carotid, femoral a.)
  - the decision to begin CPR must be within 10 sec.
- **CPR indicated if:**
  - unresponsive, not breathing normally and no signs of life
  - if bradycardia < 60 /min
  - if uncertain
- **initiation 5 rescue breaths**
- **1 minute of CPR before going for assistance!**

CPR strategy in children

- **ventilation = important in asphyxial cardiac arr.**
- 5 initial breaths, f 12-20/min, Vt according to chest rise, normoventilation
- if unwilling to breathe, then hands-only CPR better

- **external chest compressions:**
  - in lower half of sternum!
  - depth at least by 1/3 of the chest height
  - frequency as in adults 100-120/min
- modified AED can be used in children $\geq$ 1 year
- energy level: 4J /kg


Xiphoid process
Sternum

Compression to ventilation ratio in children

- laypeople:
  - single rescuer: 30 : 2 as in adults
- rescuers with a duty to respond = healthcare workers, professionals:
  - single rescuer: 15 : 2, may use 30 : 2
    - if not achieving an adequate number of compressions
  - 2 rescuers: 15 : 2

Differences of CPR in children

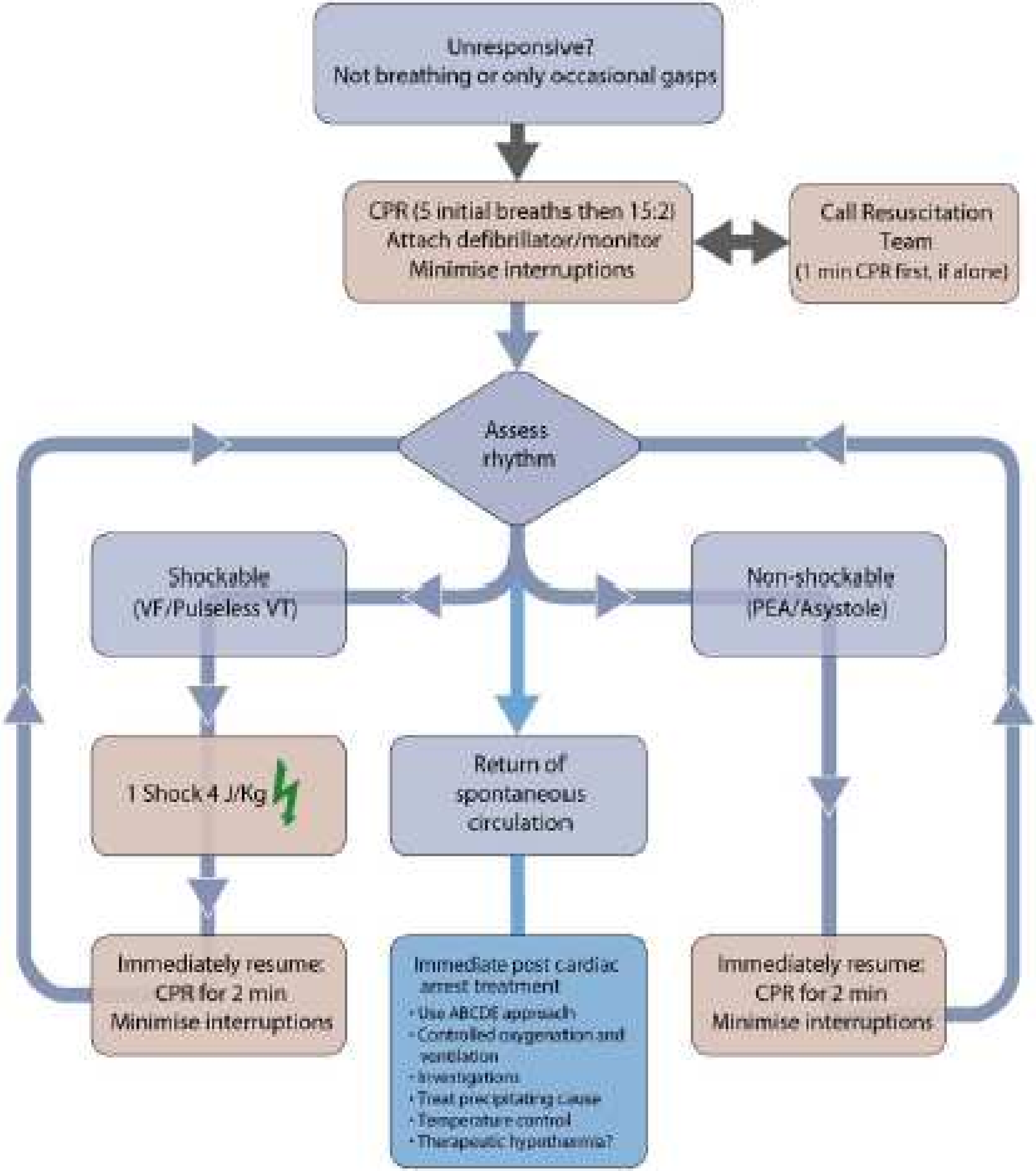
Drug administation i.v. or intraosseally prefered:

- adrenaline 0.01 mg/kg
- atropine 0.02 mg/kg
  (dose < 0.1 mg can increase bradycardia)
- amiodarone, or lidocaine

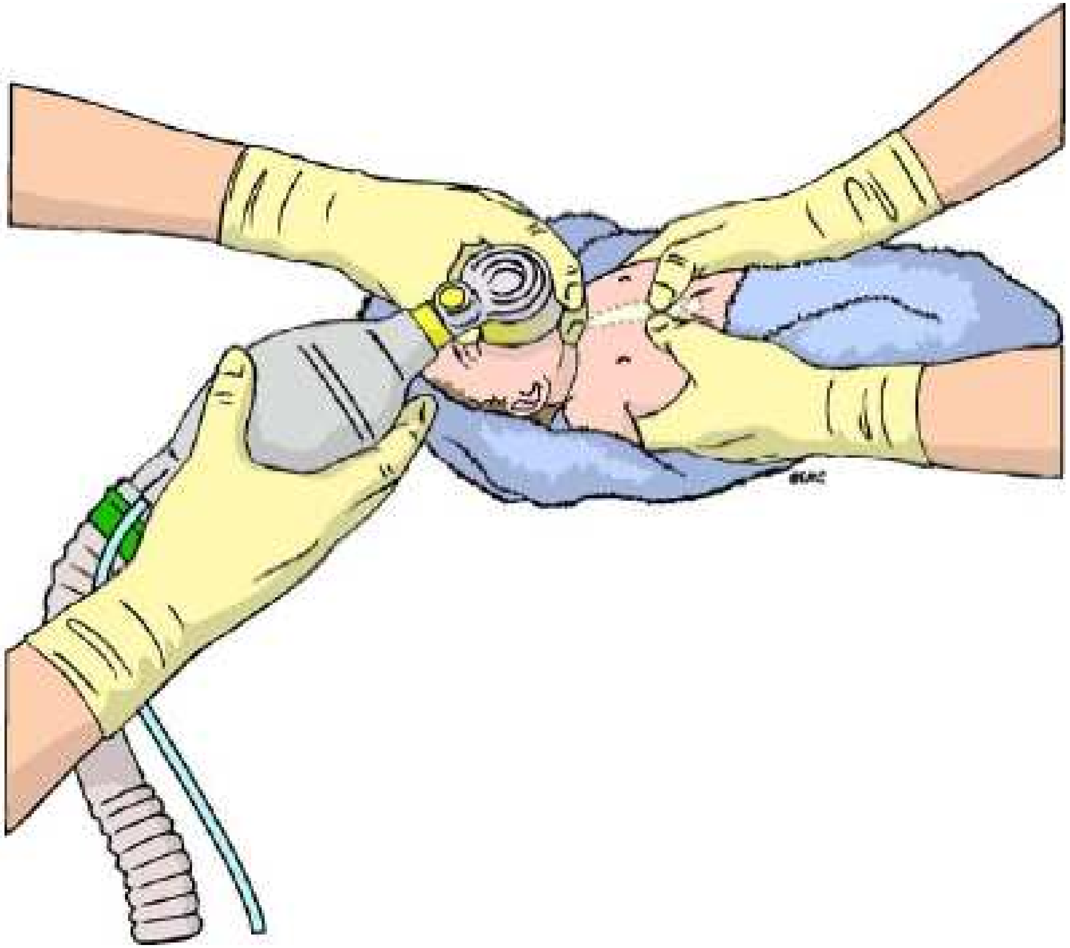
Drug administration intratracheally:

- adrenaline 0.1 mg/kg
- lidocaine 2–3 mg/kg
- atropine 0.03 mg/kg
- dilute to 5 ml, then 5 rescue breaths

Paediatric Advanced Life Support



Newly born CPR



Virginia Apgar 1952

APGAR score

Points:	0	1	2
A (Atmung)	0,	shallow,	cry
P (Pulse)	0,	<100,	≥ 100
G (Grundtonus)	weak,	moves,	active
A (Aussehen)	blue	extr.blue,	rose
R (Reflexe)	0	face	cry

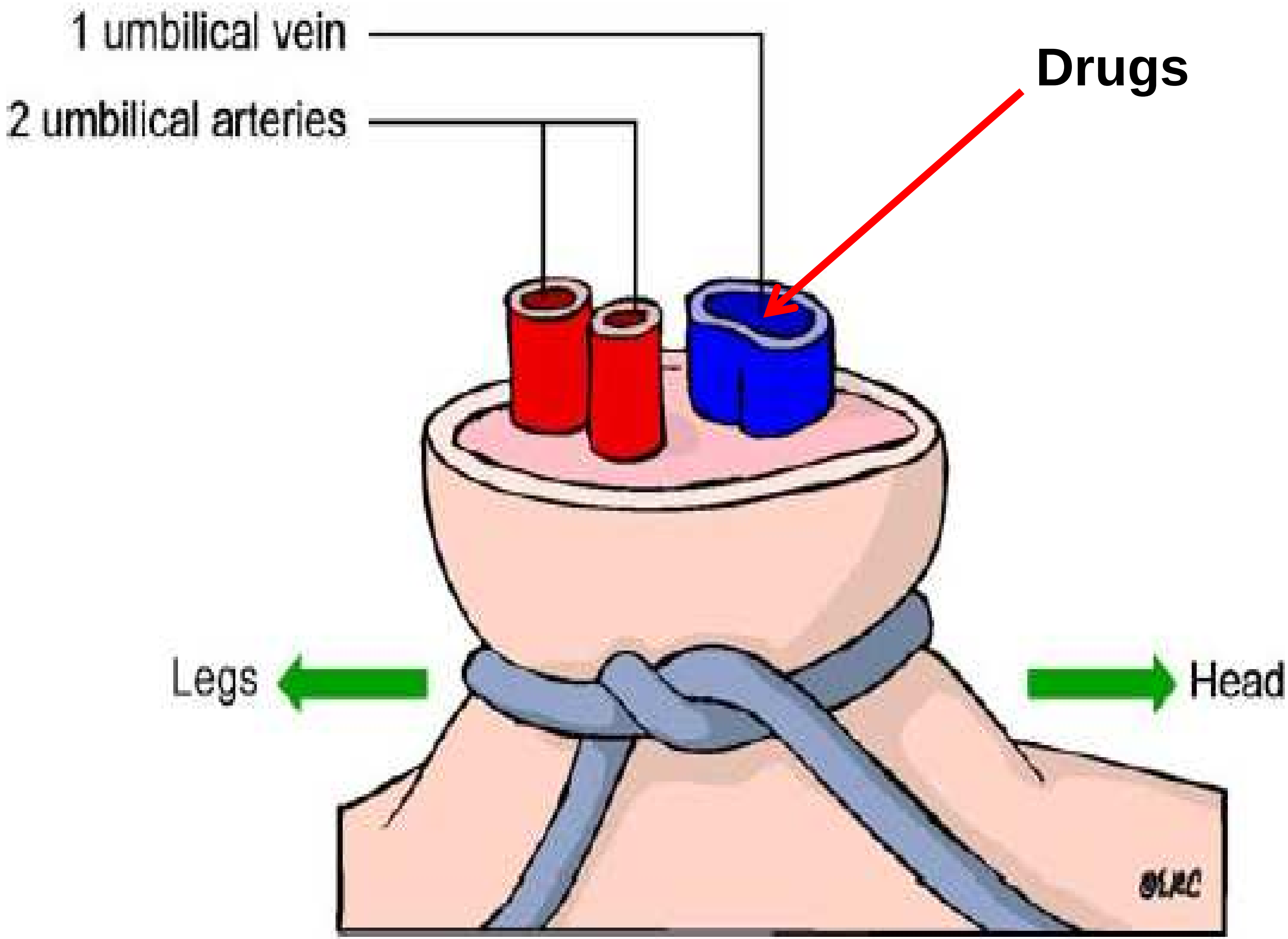
Apariencia, **P**ulso, **G**esticulación, **A**ctividad, **R**espiración

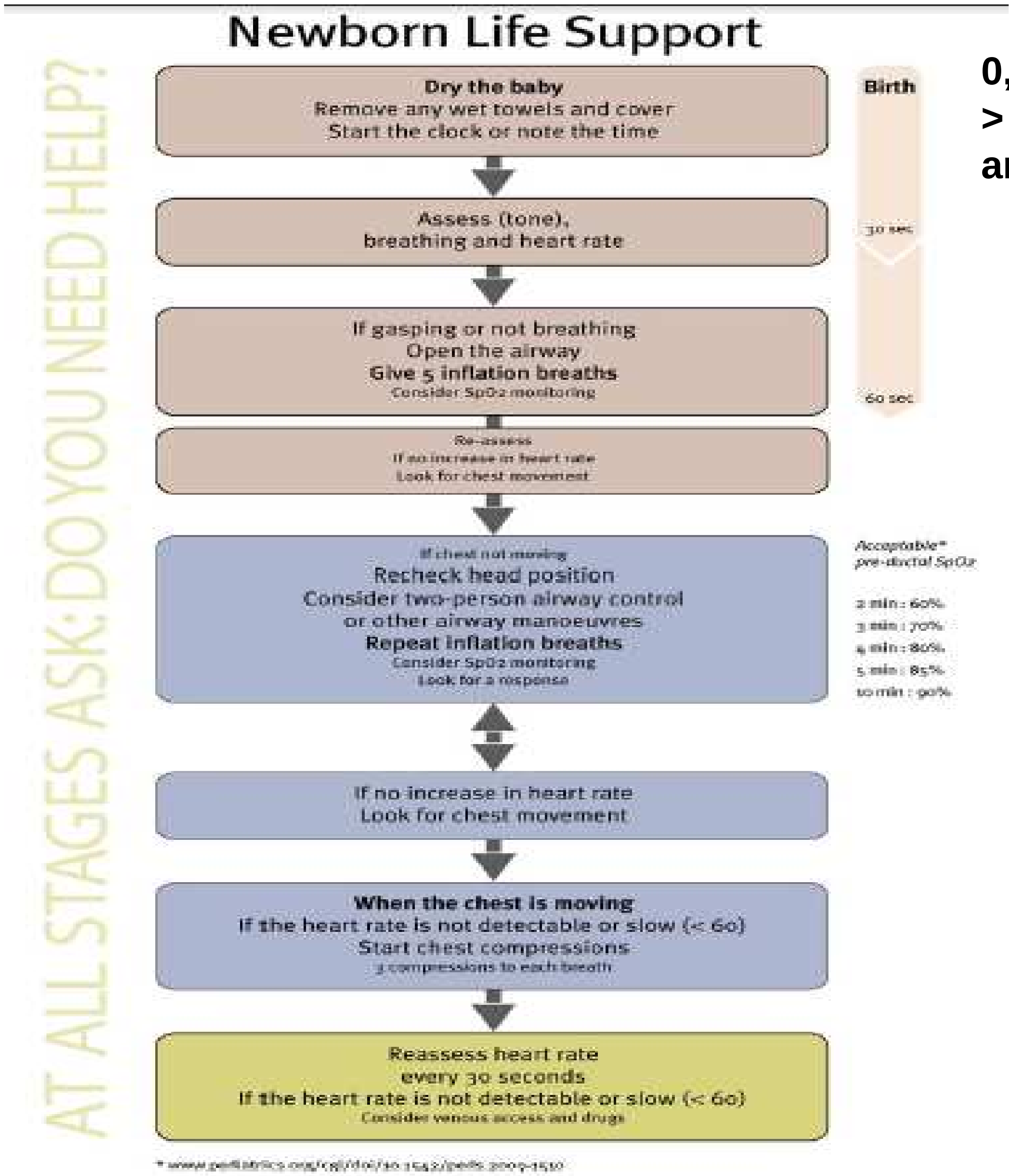
Classification according to initial assessment (APG or APT)

- **No intervention other than drying**
  - A: vigorous breathing or crying
  - P: heart rate > 100/min
  - G or T: good tone
- **Dry, wrap, mask inflation ± chest compressions**
  - A: breathing inadequate or apnoeic
  - P: heart rate ≤ 100/min
  - G or T: normal or reduced tone
- **Dry, wrap. immediate airway control, lung inflation, ventilation, chest compressions and perhaps drugs**
  - A: breathing inadequate or apnoeic
  - P: low or undetectable heart rate
  - G or T: floppy
  - often pale suggesting poor perfusion

Newly born CPR

- in uncompromised babies delay ≥ 1 min between delivery and clamping the cord recommended
- prevention of hypothermia (dry, wrap)
- air should be used for resuscitation at birth for babies in term (lung distension a priority)
- CV ratio 3:1
- fluid rarely, initial bolus crystalloid 10 ml/kg


1 umbilical vein
2 umbilical arteries
Drugs
Legs
Head
©LRC



0,2-1,0% children
> 32nd week
and 2500 g

Resuscitation 81 (2010) 1400–1433

Contents lists available at ScienceDirect

Resuscitation

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European Resuscitation Council Guidelines for Resuscitation 2010 Section 8. Cardiac arrest in special circumstances: Electrolyte abnormalities, poisoning, drowning, accidental hypothermia, hyperthermia, asthma, anaphylaxis, cardiac surgery, trauma, pregnancy, electrocution

Prognostication

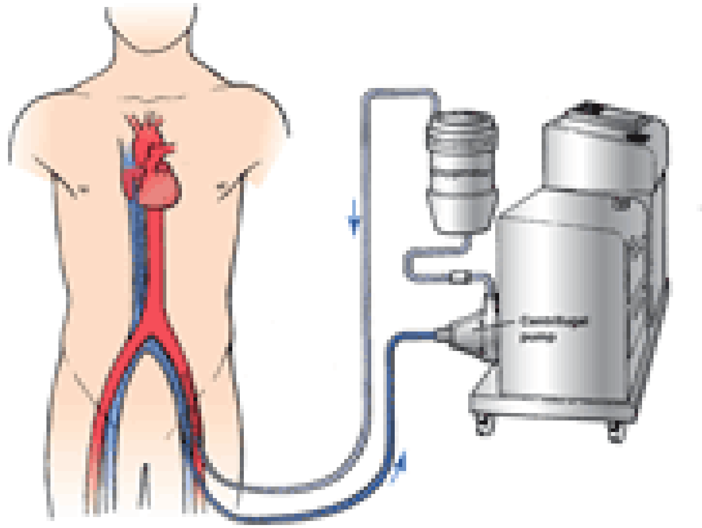
- return of spontaneous circulation 25-50%
- survival:
  - out-of-hospital cardiac arrest 5%
  - in-hospital cardiac arrest 20%
- quality of survival:
  - cerebral performance category 1-5
  - poor outcome:
    - photoreaction and corneal reflex absent ≥ 72 h
    - myoclonus
  - NSE, S100

Future

- percutaneous ECMO

↓

- „hearts too good to die“
- „brains too good to die“



- centers for cardiac arrests > 40-50/rok