1ο Εκπαιδευτικό Συμπόσιο με θέμα «**Επείγοντα στην Πνευμονολογία**» Α' Κλινική Εντατικής Θεραπείας ΕΚΠΑ, Γ.Ν.Α. "Ο Ευαγγελισμός" 26-27 Μαΐου 2017

Δεν υπάρχει σύγκρουση συμφερόντων με τις παρακάτω χορηγούς εταιρείες:

ASPEN
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ELPEN
GLAXOSMITHKLINE
MENARINI HELLAS
NOVARTIS
PFIZER

Cardiac Arrest in Patients with Acute Respiratory Failure

Spyros Mentzelopoulos

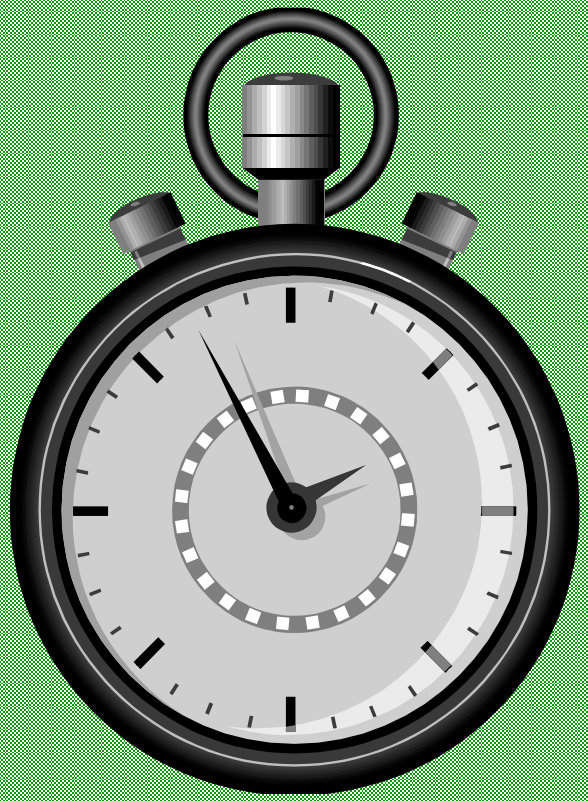
www.erc.edu

Introduction

- Cardiac Arrest: ≈ 1000000 Deaths / year in Europe
- 40% VF (= Chaotic depolarization and repolarization)
- Prompt recognition and call for help
- Immediate CPR ↑ survival by x2-x3
- Prompt Defibrillation (3-5 min): survival 49-75%, every delay of 1 min reduces survival by 10-15%
- Timely ALS and appropriate postresuscitation care
- In VF, for every 1 min without CPR survival ↓ by 7-10%
- In VF, for 1 min of CPR without ROSC survival ↓ 3-4%

Chain of Survival

Time = Brain!



- Irreversible Brain Damage within 5 min of collapse
- Begin BLS immediately

BLS

Fig. 2.3. The BLS/AED Algorithm.

In-hospital Resuscitation

Collapsed / sick patient

Shout for HELP & assess patient

Signs of life?

No

Call resuscitation team

CPR 30:2
with oxygen and airway adjuncts

Apply pads/monitor
Attempt defibrillation
if appropriate

Advanced Life Support
when resuscitation team arrives

Yes

Assess ABCDE
Recognise & treat
Oxygen, monitoring,
IV access

Call resuscitation team if appropriate

Handover to resuscitation team

Advanced Life Support

Unresponsive and not breathing normally?

Call Resuscitation Team

CPR 30:2
Attach defibrillator/monitor
Minimise interruptions

Assess rhythm

Shockable (VF/Pulseless VT)

1 Shock
Minimise interruptions

Immediately resume CPR for 2 min
Minimise interruptions

Return of spontaneous circulation

Non-shockable (PEA/Asystole)

Immediately resume CPR for 2 min
Minimise interruptions

IMMEDIATE POST – CARDIAC ARREST TREATMENT

- Use ABCDE approach
- Aim for SaO_2 of 94–98%
- Aim for normal $PaCO_2$
- 12-lead ECG
- Treat precipitating cause
- Targeted temperature management

Advanced Life Support

DURING CPR

- Ensure high quality chest compressions
- Minimise interruptions to compressions
- Give oxygen
- Use waveform capnography
- Continuous compressions when advanced airway in place
- Vascular access (intravenous or intraosseous)
- Give adrenaline every 3–5 min
- Give amiodarone after 3 shocks

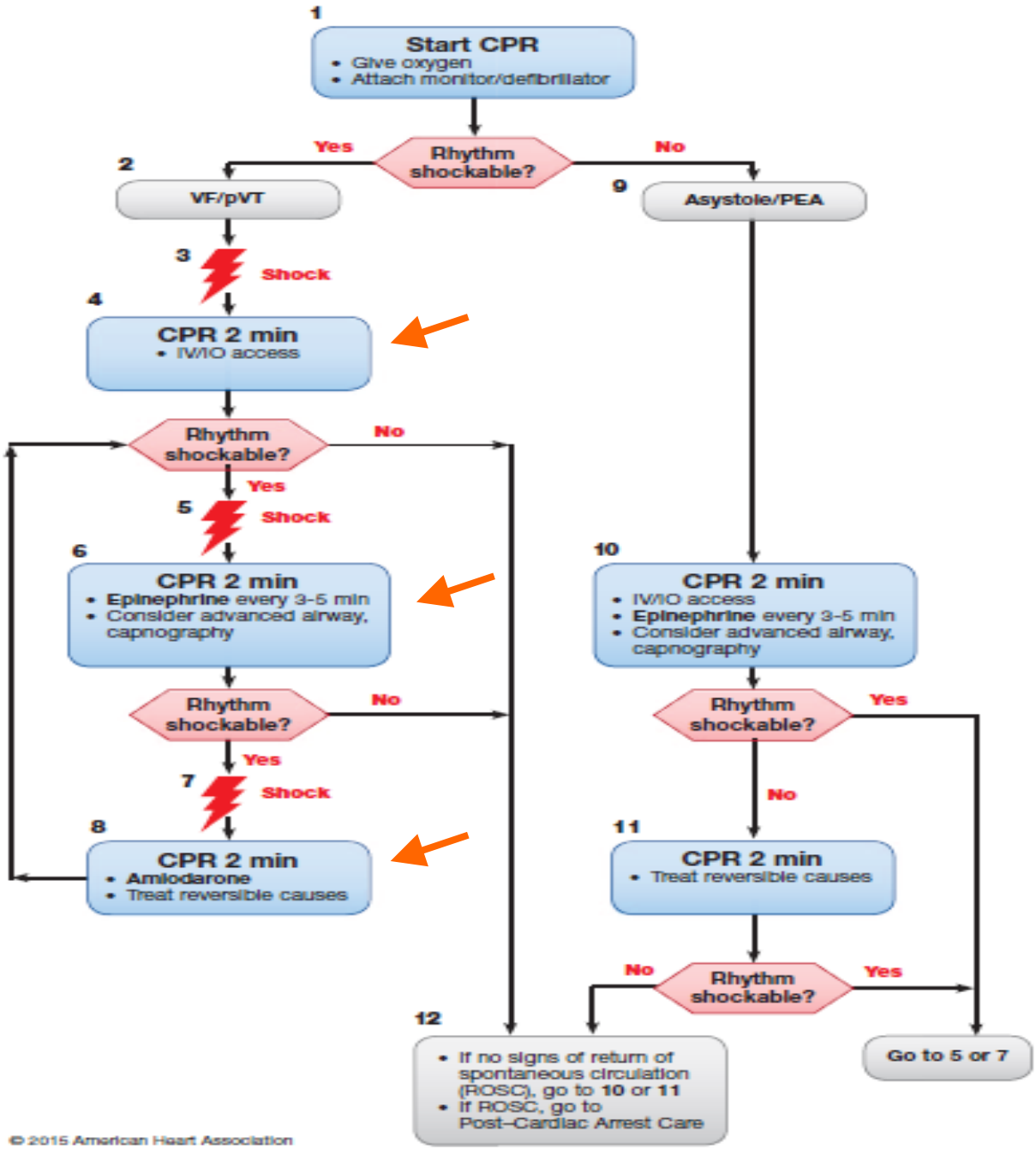
TREAT REVERSIBLE CAUSES

Hypoxia	Thrombosis – coronary or pulmonary
Hypovolaemia	Tension pneumothorax
Hypo–/hyperkalaemia/metabolic	Tamponade – cardiac
Hypothermia/hyperthermia	Toxins

CONSIDER

- Ultrasound imaging
- Mechanical chest compressions to facilitate transfer/treatment
- Coronary angiography and percutaneous coronary intervention
- Extracorporeal CPR

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.
- Rotate 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.

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

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

ERC Guidelines 2015

Causes of asphyxial cardiac arrest

- Airway obstruction: soft tissues (coma), laryngospasm, aspiration
- Anaemia
- Asthma
- Avalanche burial
- Central hypoventilation – brain or spinal cord injury
- Chronic obstructive pulmonary disease
- Drowning
- Hanging
- High altitude
- Impaired alveolar ventilation from neuromuscular disease
- Pneumonia
- Tension pneumothorax
- Trauma
- Traumatic asphyxia or compression asphyxia (e.g. crowd crush)

Immediate causes of CA in ARF

Diagnose and actively treat / reverse CA causes:

- Hypoxemia due to V/Q abnormalities
- Hypercapnic acidosis
- Bronchospasm
- Hypo / hyperkalemia, hypomagnesemia
- Major Airway Obstruction
- Pneumothorax
- Toxins

Cause – specific Algorithms and / or Recommendations

Anaphylaxis

Anaphylactic reaction?

Airway, **B**reathing, **C**irculation, **D**isability, **E**xposure

Diagnosis - look for:

- Acute onset of illness
- Life-threatening Airway and/or Breathing and/or Circulation problems[1]
- And usually skin changes

- **Call for help**
- Lie patient flat with raised legs (if breathing allows)

Adrenaline[2]

Anaphylaxis

When skills and equipment available:

- Establish airway
- High flow oxygen
- IV fluid challenge[3]
- Chlorphenamine[4]
- Hydrocortisone[5]

Monitor:

- Pulse oximetry
- ECG
- Blood pressure

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[1] **Life-threatening problems:**
Airway: swelling, hoarseness, stridor
Breathing: rapid breathing, wheeze, fatigue, cyanosis, SpO_2 < 92%, confusion
Circulation: pale, clammy, low blood pressure, faintness, drowsy/coma

[2] **Adrenaline** *(give IM unless experienced with IV adrenaline)*
IM doses of 1:1000 adrenaline (repeat after 5 min if no better)

Adult	500 microgram	IM (0.5 mL)
Child more than 12 years	500 microgram	IM (0.5 mL)
Child 6–12 years	300 microgram	IM (0.3 mL)
Child less than 6 years	150 microgram	IM (0.15 mL)

Adrenaline IV to be given **only by experienced specialists**
Titrate: Adults 50 mcg; Children 1 mcg kg^{-1}

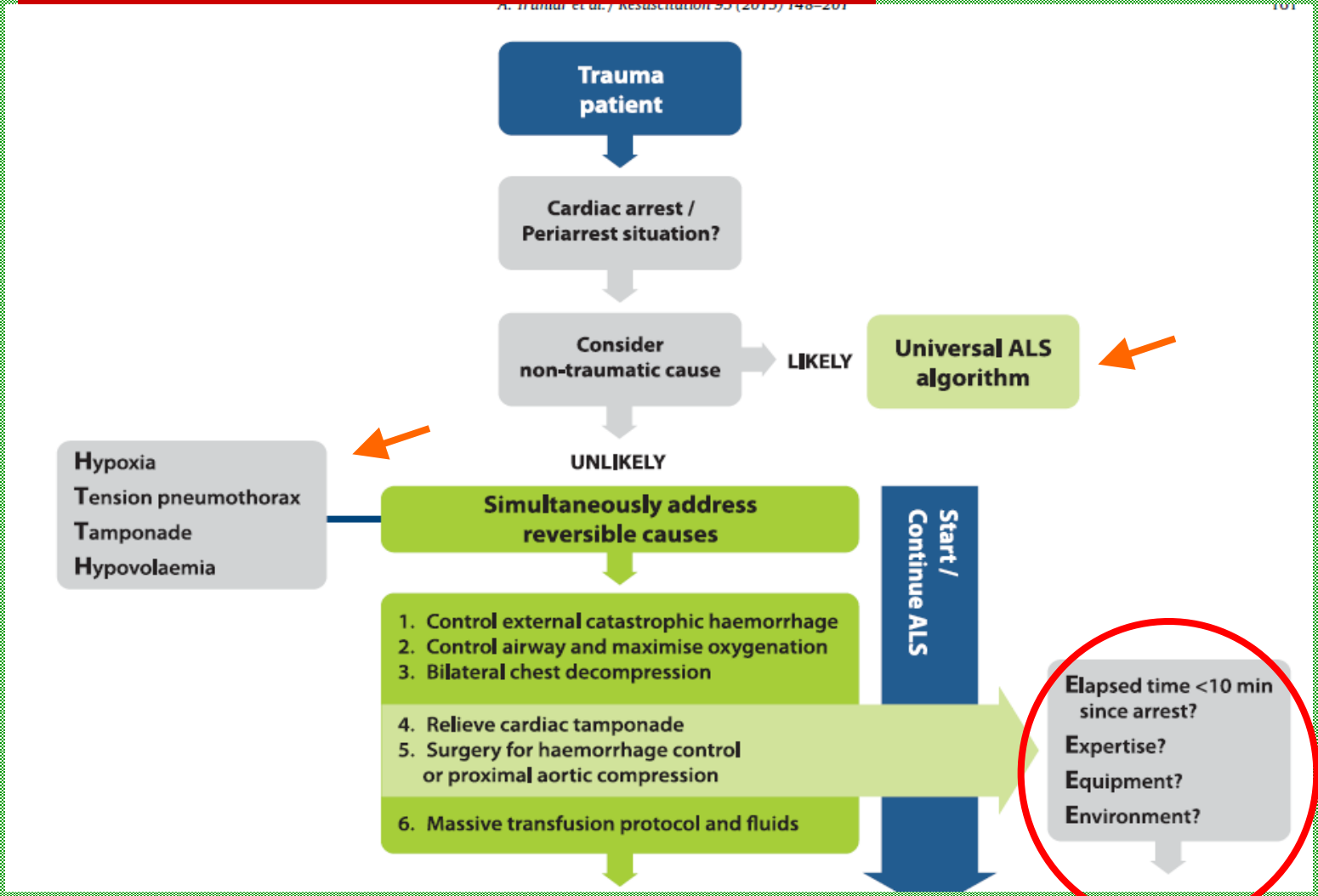
[3] **IV fluid challenge (crystalloid):**

Adult 500 – 1000 mL
Child 20 mL kg^{-1}

Stop IV colloid if this might be the cause of anaphylaxis

	[4] Chlorphenamine (IM or slow IV)	[5] Hydrocortisone (IM or slow IV)
Adult or child more than 12 years	10 mg	200 mg
Child 6 – 12 years	5 mg	100 mg
Child 6 months to 6 years	2.5 mg	50 mg
Child less than 6 months	250 mcg kg^{-1}	25 mg

Traumatic Cardiac Arrest



Traumatic Cardiac Arrest

Consider termination of CPR

NO

Return of spontaneous circulation?

Consider immediate resuscitative thoracotomy

YES

Pre-hospital:

- Perform only life-saving interventions
- Immediate transport to appropriate hospital

In-hospital:

- Damage control resuscitation
- Definitive haemorrhage control

Pulmonary Embolism

2015 Recommendations—New and Updated

ALS Modification: Confirmed Pulmonary Embolism

In patients with confirmed PE as the precipitant of cardiac arrest, thrombolysis, surgical embolectomy, and mechanical embolectomy are reasonable emergency treatment options (Class IIa, LOE C-LD). Comparative data are not available to recommend one strategy over another. Patient location, local intervention options, and patient factors (including thrombolysis contraindications) are recognized elements to be considered. Thrombolysis can be beneficial even when chest compressions have been provided (Class IIa, LOE C-LD). Given the poor outcomes associated with fulminant PE in the absence of clot-directed therapy, standard contraindications to thrombolysis may be superseded by the need for potentially lifesaving intervention.

ALS Modifications: Suspected Pulmonary Embolism

Thrombolysis may be considered when cardiac arrest is suspected to be caused by PE (Class IIb, LOE C-LD). There is no consensus on inclusion criteria (eg, risk factors, signs, or symptoms that constitute suspected PE), thrombolytic timing, drug, or dose in this situation. There are insufficient data on surgical and mechanical embolectomy to evaluate these therapies for cardiac arrest associated with suspected but unconfirmed PE.

Poisonings - Opioids

Opioid-Associated Life-Threatening Emergency (Adult) Algorithm—New 2015

Assess and activate.
Check for unresponsiveness and call for nearby help. Send someone to call 9-1-1 and get AED and naloxone. Observe for breathing vs no breathing or only gasping.

Begin CPR.
If victim is unresponsive with no breathing or only gasping, begin CPR.* If alone, perform CPR for about 2 minutes before leaving to phone 9-1-1 and get naloxone and AED.

Administer naloxone.
Give naloxone as soon as it is available. 2 mg intranasal or 0.4 mg intramuscular. May repeat after 4 minutes.

Poisonings - Opioids

Does the person respond?
At any time, does the person move purposefully, breathe regularly, moan, or otherwise respond?

Yes

Stimulate and reassess.
Continue to check responsiveness and breathing until advanced help arrives. If the person stops responding, begin CPR and repeat naloxone.

No

Continue CPR and use AED as soon as it is available.
Continue until the person responds or until advanced help arrives.

Principles of Postresuscitation Care

- Avoid Hypotension
- Correct Acidosis and Electrolyte disturbances
- Treat underlying pathophysiology
- Targeted Temperature Management
- Avoid Hypocapnia
- Avoid Hyperoxia
- Exclude Myocardial Ischemia
- Lung-protective ventilation
- Treat infection without delay

Significance of arterial hypotension after resuscitation from cardiac arrest*

Crit Care Med 2009;31:2895-903

Stephen Trzeciak, MD, MPH; Alan E. Jones, MD; J. Hope Kilgannon, MD; Barry Milcarek, PhD; Krystal Hunter, MBA; Nathan I. Shapiro, MD, MPH; Steven M. Hollenberg, MD; R. Phillip Dellinger, MD; Joseph E. Parrillo, MD

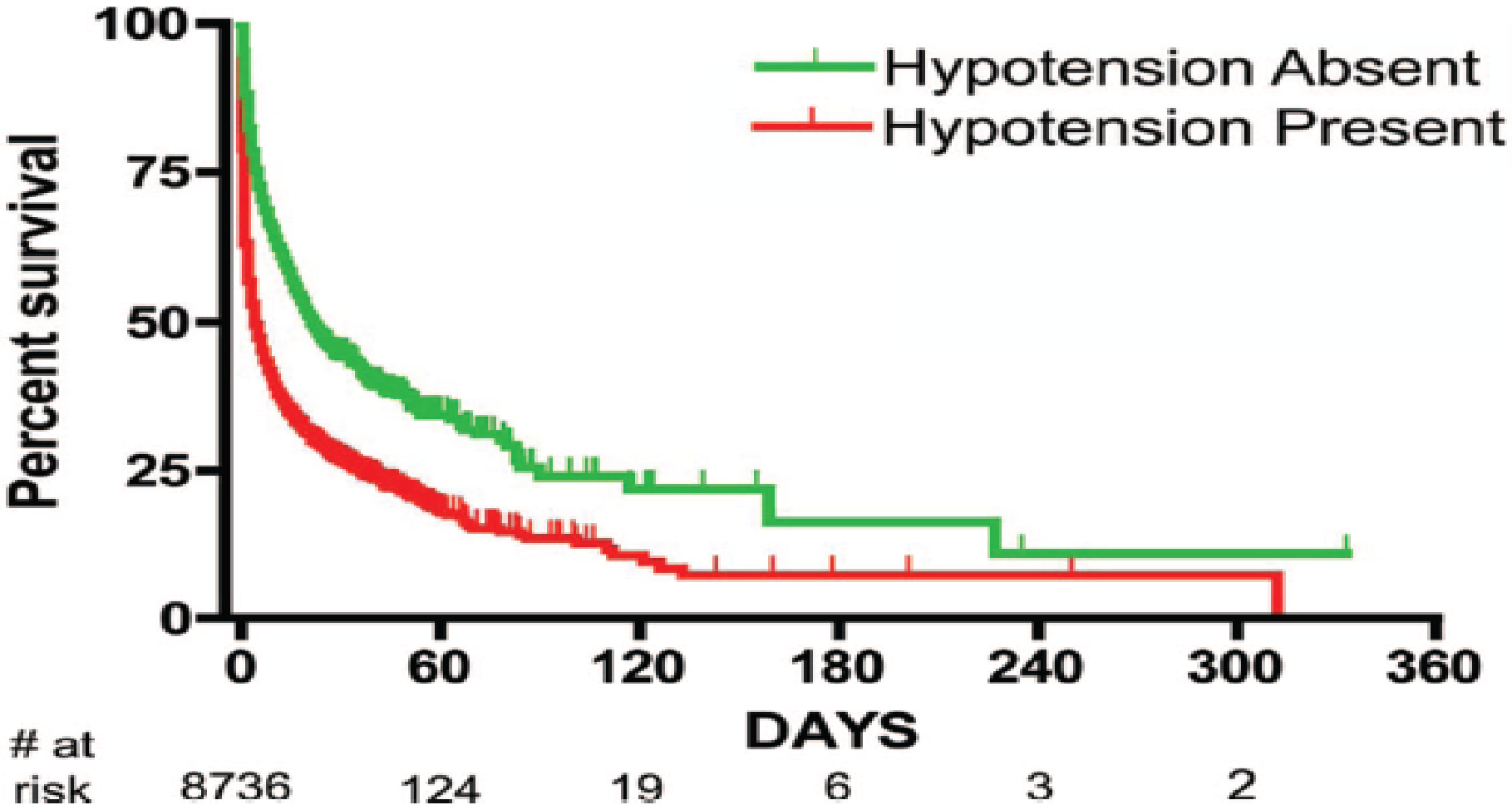


Figure 1. Kaplan-Meier survival curves for patients with Hypotension Present and Hypotension Absent after return of spontaneous circulation from cardiac arrest (with censoring). The survival fractions diverged significantly by log-rank test ($p < .001$).

Homeostasis

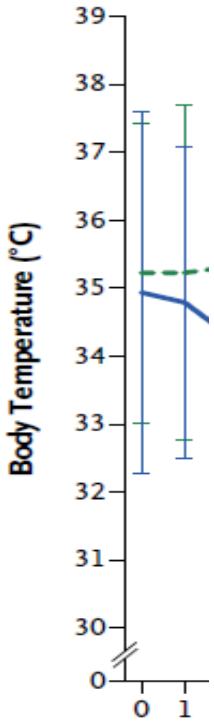
- Correct Acidosis and Electrolyte disturbances
- pHa < 7.1 – consider $NaHCO_3$
- Acidosis correction may unmask severe Hypokalemia!
- Do not forget Mg++!
- If anuria persists > 2 h consider CVVDHF

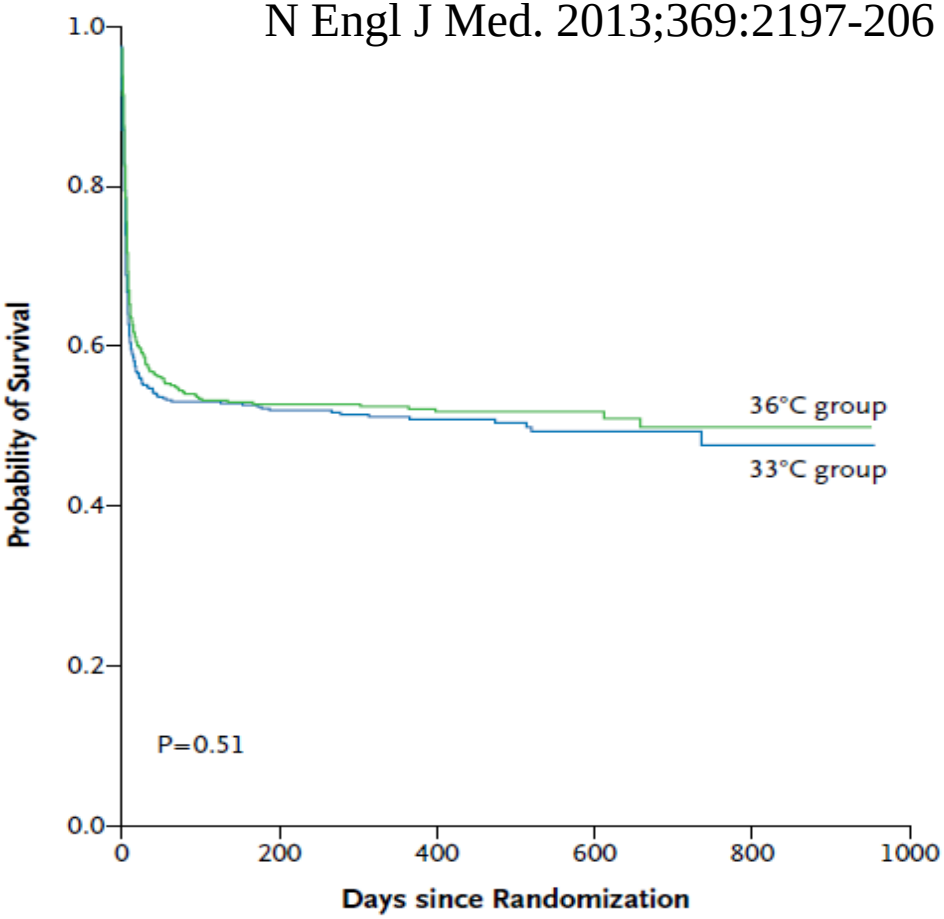
Reverse underlying pathophysiology

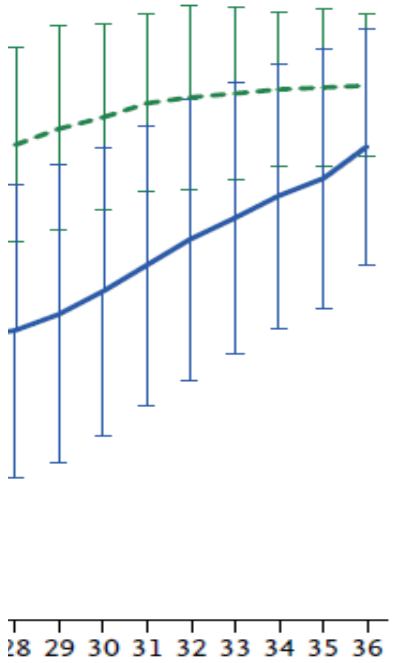
- Bronchodilators [Asthma – COPD]
- Steroids [Asthma – COPD – ARDS – non-viral Pneumonia – Laryngeal edema]
- Diuretics [Pulmonary Edema]
- Lung protective ventilation + low-PEEP [Asthma – COPD]
- Lung-protective ventilation + high-PEEP, Prone Position, ECMO, HFO [ARDS]. Relief of any concurrent IAH.
- Cultures / specific tests + Broad antibiotic coverage ± antiviral drugs

Targeted Temperature Management

N Engl J Med. 2013;369:2197-206







No. at Risk					
33°C group	473	230	151	64	15
36°C group	466	235	144	68	12

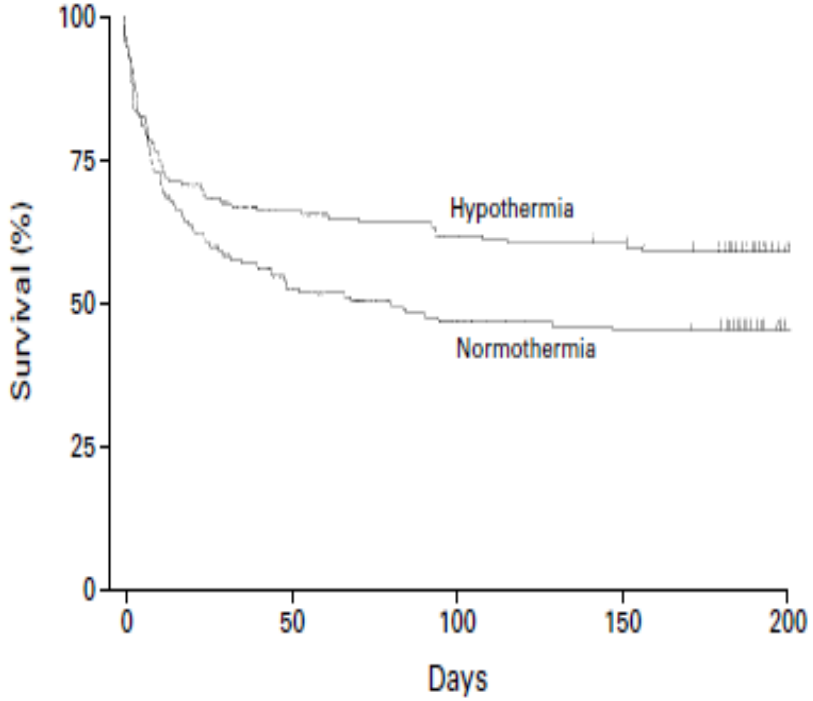
Targeted Temperature Management

NEJM 2002;346:557-63

TABLE 5. OUTCOME OF PATIE
FROM THE HOSI

OUTCOME*	
Normal or minimal disability (able to care fo self, discharged directly to home)	
Moderate disability (discharged to a rehabi itation facility)	
Severe disability, awake but completely dependent (discharged to a long-term nursing facility)	
Severe disability, unconscious (discharged to a long-term nursing facility)	
Death	

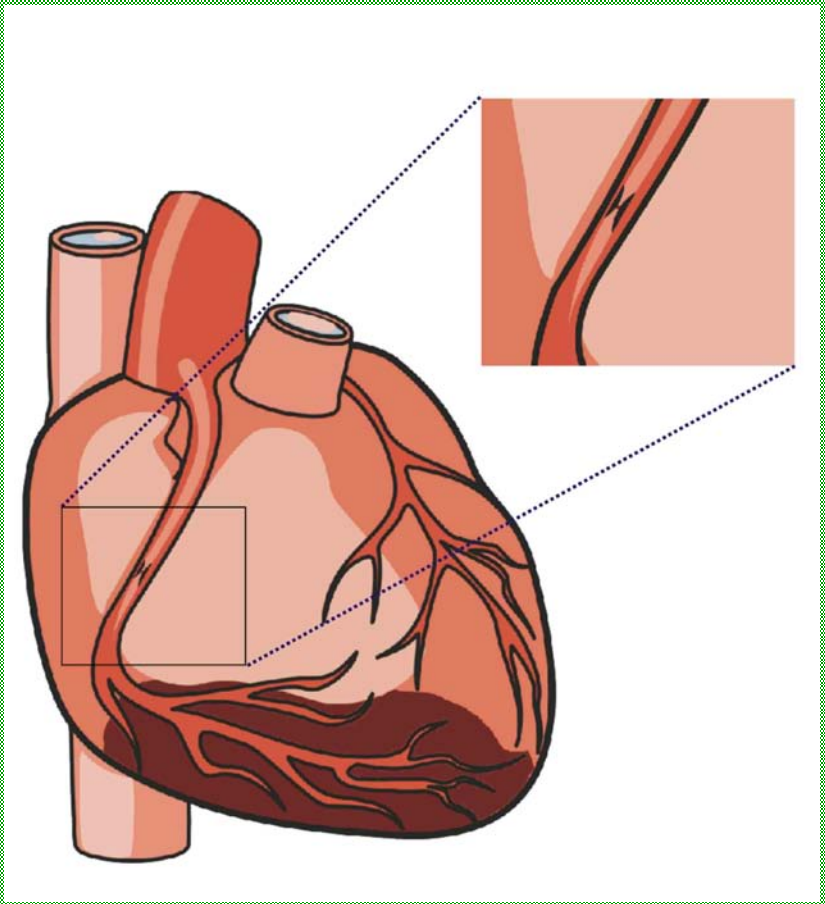
NEJM 2002;346:549-56



NO. AT RISK					
Hypothermia	137	92	86	83	11
Normothermia	138	74	66	64	9

Figure 2. Cumulative Survival in the Normothermia and Hypothermia Groups. Censored data are indicated by tick marks.

60 % of Deaths in CAD are due to Cardiac Arrest!



- Atherosclerosis
- Infarction
- Cardiac Arrest

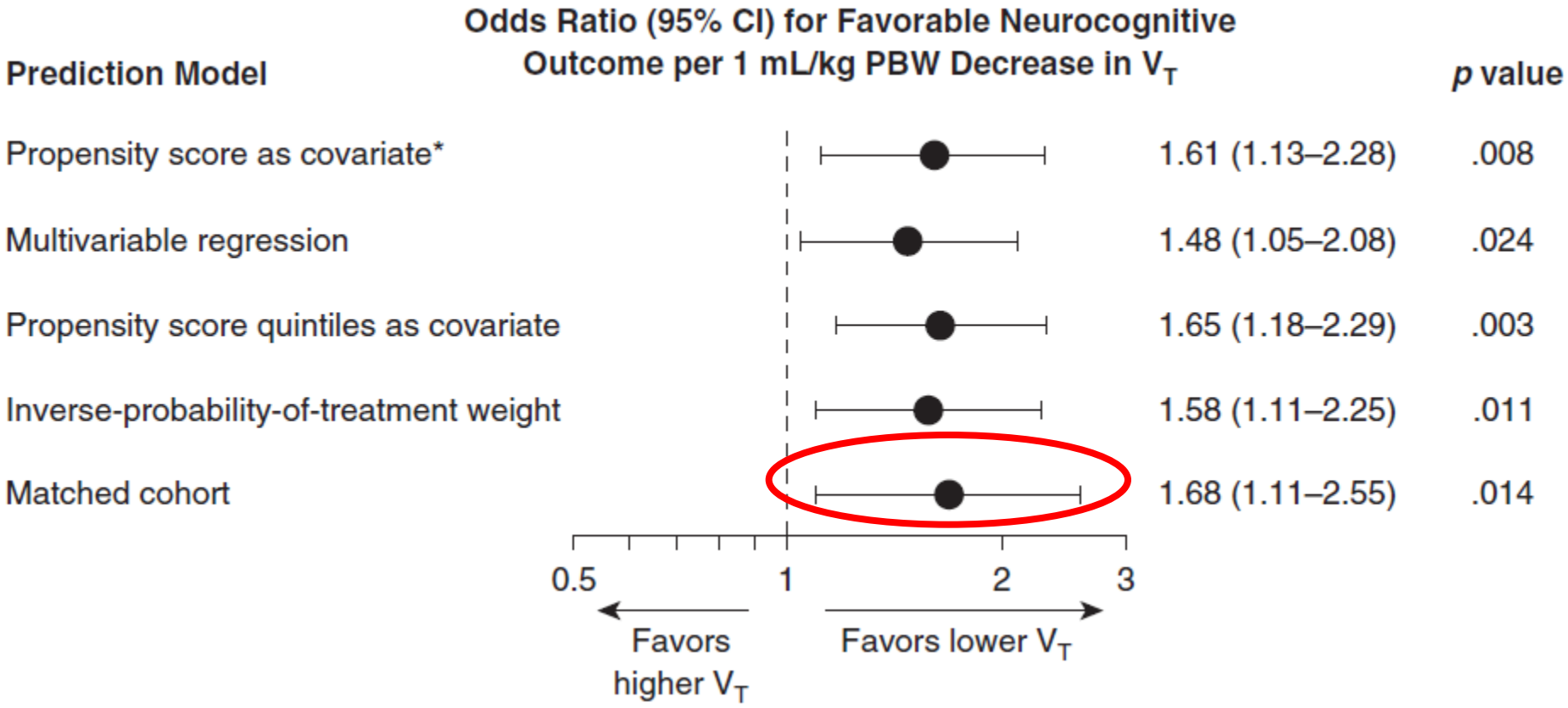
Early Coronary Angiography and Survival After Out-Of-Hospital Cardiac Arrest

Circ Cardiovasc Interv. 2015 October ; 8(10): . doi:10.1161/CIRCINTERVENTIONS.114.002321

Unadjusted and adjusted association of early coronary angiography with survival to discharge and favorable neurologic outcome

Cohort	Survival to Discharge		Favorable Neurological Outcome	
	OR	95% CI	OR	95% CI
Unadjusted (Before Matching)# (N = 4,029)	2.16	1.89 – 2.47	2.18	1.92 – 2.47
Propensity Matched* (N = 2,624) – all patients	1.52	1.28 – 1.80	1.47	1.25 – 1.71
Propensity Matched for patients identified as not having a STEMI * (N = 620)	1.29	0.87 – 1.90	1.60	1.14 – 2.26

Low Vt and Outcome
AJRCCM 2017; 195:1198-206



Summary

- Cardiac Arrest in ARF is mainly due to hypoxemia ± acidosis ± electrolyte disturbances
- Severe hypoxemia due to ARDS may be treatable only with Prone position, HFO, or ECMO
- Immediately treatable if due to Pneumothorax, or Pulmonary Edema before tracheal intubation, or Respiratory Depressant Drugs

Main objectives of Postresuscitation Care

- No Hypotension
- No Severe Disturbances of Homeostasis
- No Fever – TTM to 36 °C Core Temperature
- No Hypocapnia to prevent ↓CBF
- No Hyperoxia to prevent O_2 toxicity
- Exclusion of Myocardial Infarction
- Prompt treatment of Infection
- Prevention of VALI