
# Post ROSC : bundles di trattamento nell'adulto

**Iole Brunetti**

U.O.C Anestesia e Terapia Intensiva
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Anaesthesia, 2007, **62**, pages 1207–1216 doi:10.1111/j.1365-2044.2007.05232.x

# Outcome following admission to UK intensive care units after cardiac arrest: a secondary analysis of the ICNARC Case Mix Programme Database*

**J. P. Nolan,[1] S. R. Laver,[2] C. A. Welch,[3] D. A. Harrison,[4] V. Gupta[5] and K. Rowan[6]**



**Table 1** Case mix, physiology, treatment, activity and outcome.

| | Community | In-hospital, peri-operative | In-hospital, not peri-operative | All |
|---|---|---|---|---|
| **Case mix** | | | | |
| Admissions; *n* (%*) | 8987 (13.8) | 2973 (1.6) | 12 172 (7.3) | 24 132 (5.8) |
| Age; mean (SD) | 59.8 (18.7) | 64.1 (17.5) | 63.4 (16.5) | 62.1 (17.6) |
| Sex (years); *n* (%) | | | | |
| Male | 5374 (59.8) | 1732 (58.3) | 6906 (56.7) | 14 012 (58.1) |
| Female | 3613 (40.2) | 1241 (41.7) | 5266 (43.3) | 10 120 (41.9) |
| **Outcome** | | | | |
| ICU mortality; *n* (%) | 5090 (56.6) | 1310 (44.1) | 7372 (60.6) | 13 772 (57.1) |
| Ultimate hospital mortality; *n* (%) | 6338 (71.4) | 1639 (56.1) | 8945 (75.2) | 16 922 (71.4) |

- 174 ICU
- 24132 cardiac arrest

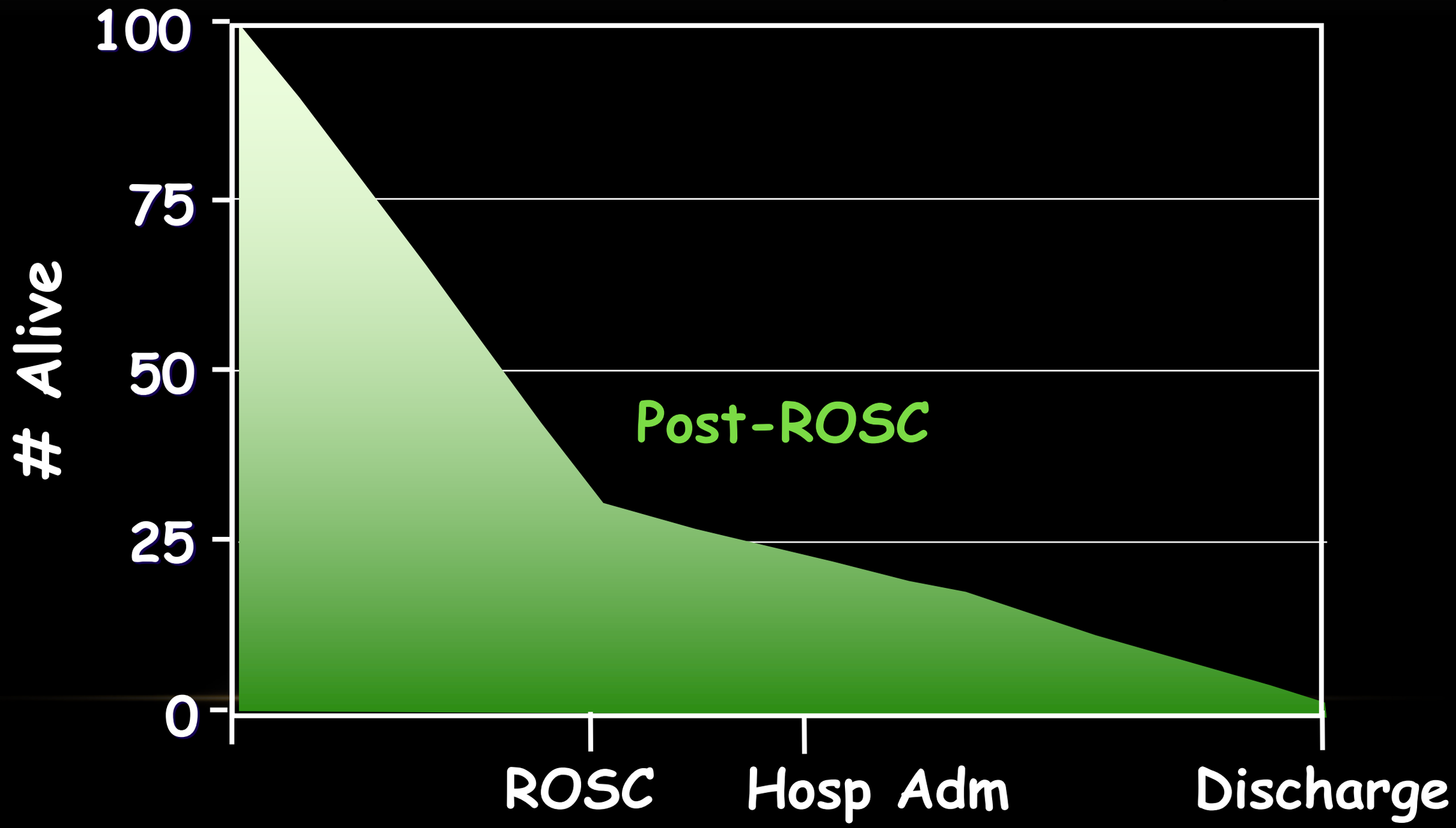
intra and out of hospital

**ICU mortality 57,15 %**

**Hospital mortality 71,4 %**


# SURVIVAL AFTER CARDIAC ARREST

75% dead in Hospital



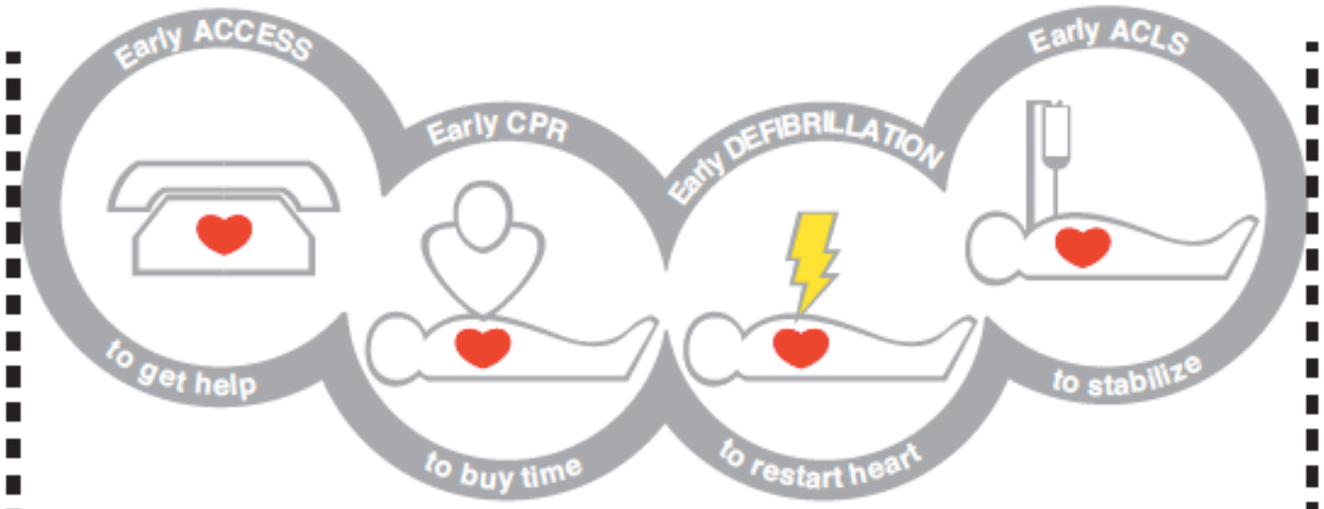

# Survival Chain

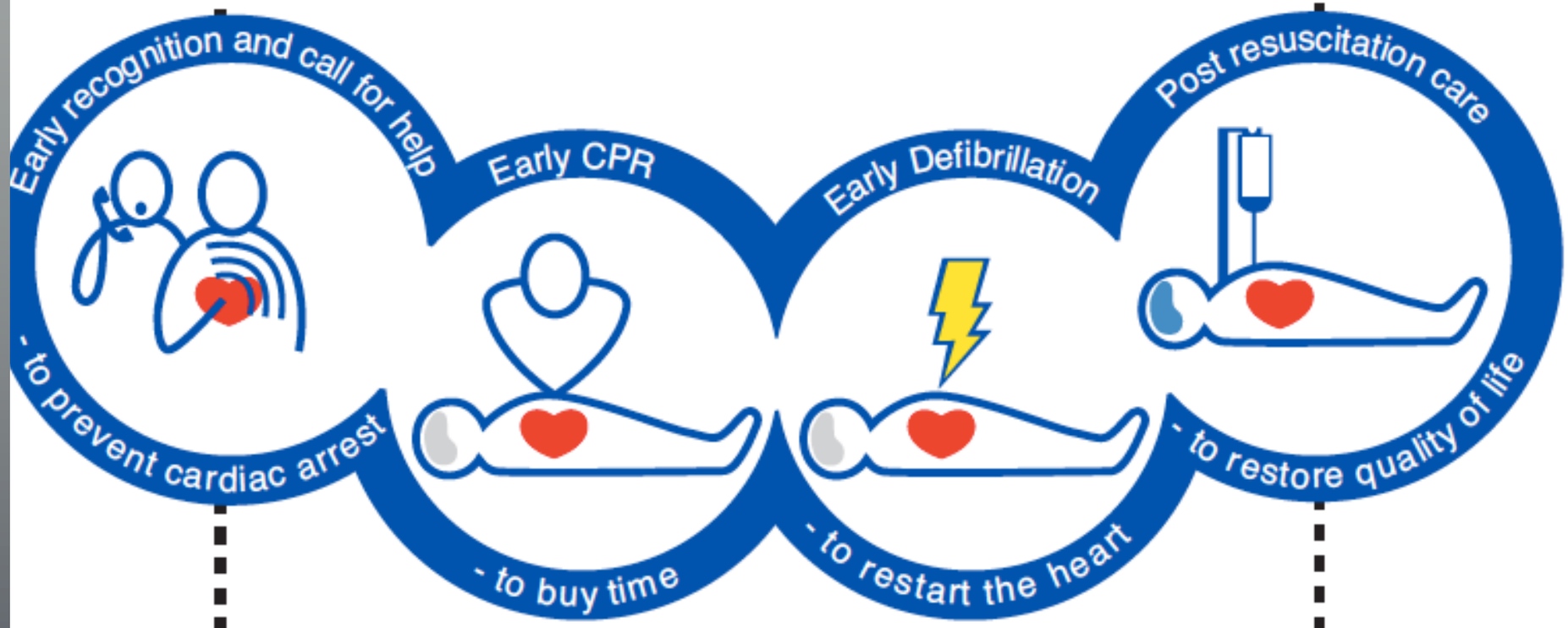
2003

2005

2010

2015



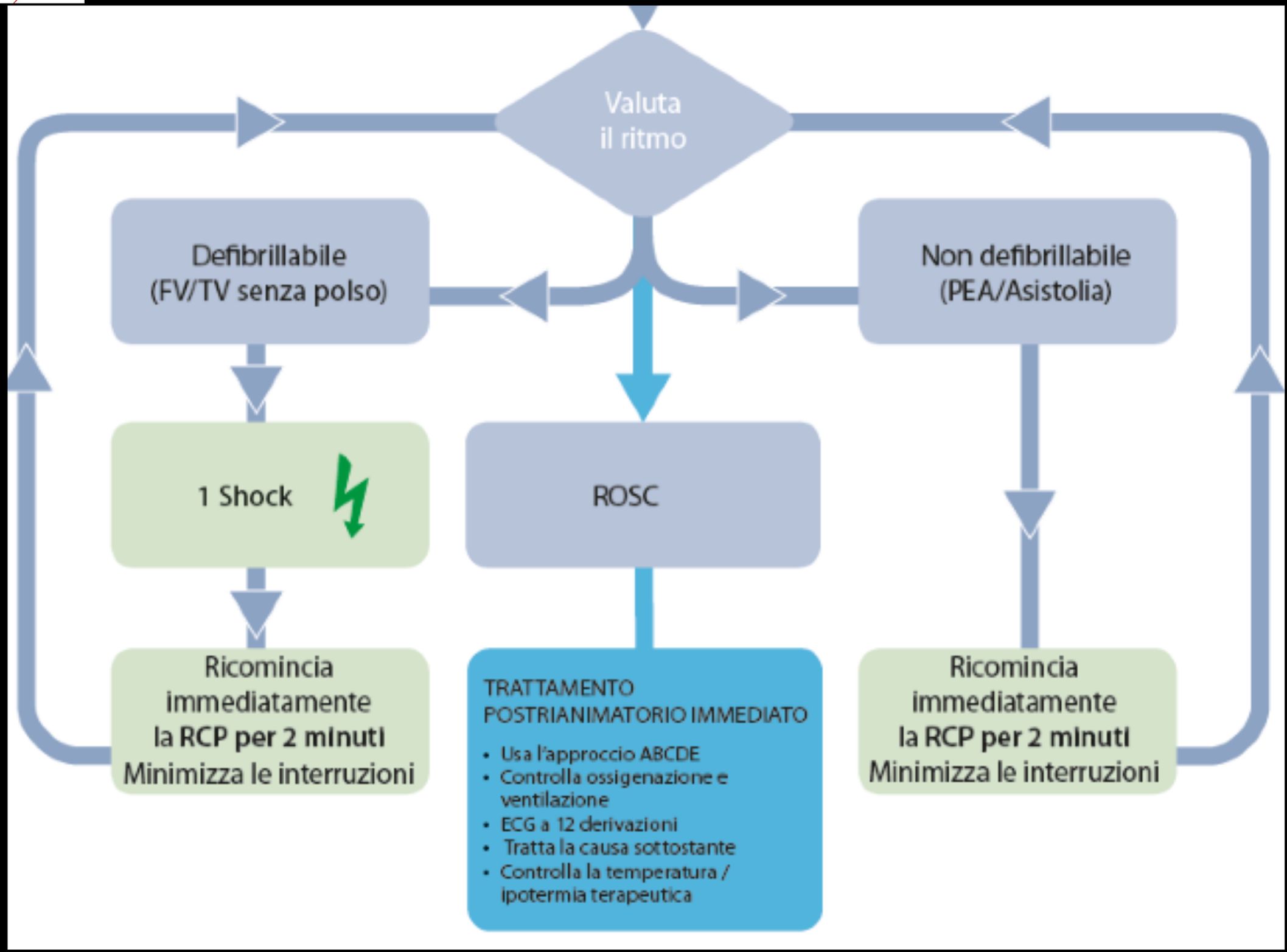

Pre-incident

Resuscitation

Post-resuscitation


Italian Resuscitation Council
IRC
CONGRESSO NAZIONALE IRC
2017
13·14 OTTOBRE
DALL'EVIDENZA AI TRATTAMENTI FUTURI
CENTRO CONGRESSI MAGAZZINI DEL COTONE
PORTO ANTICO GENOVA

# ALS 2010


Valuta il ritmo
Defibrillabile (FV/TV senza polso)
Non defibrillabile (PEA/Asistolia)
1 Shock
ROSC
Ricomincia immediatamente la RCP per 2 minuti Minimizza le interruzioni
TRATTAMENTO POSTRIANIMATORIO IMMEDIATO
• Usa l'approccio ABCDE
• Controlla ossigenazione e ventilazione
• ECG a 12 derivazioni
• Tratta la causa sottostante
• Controlla la temperatura / ipotermia terapeutica
Ricomincia immediatamente la RCP per 2 minuti Minimizza le interruzioni


# ALS 2015

## Return of spontaneous circulation and comatose

**Immediate treatment**

**Airway and breathing**
- Maintain $SpO_2$ 94 – 98%
- Insert advanced airway
- Waveform capnography
- Ventilate lungs to normocapnia

**Circulation**
- 12-lead ECG
- Obtain reliable intravenous access
- Aim for SBP > 100 mmHg
- Fluid (crystalloid) – restore normovolaemia
- Intra-arterial blood pressure monitoring
- Consider vasopressor/ inotrope to maintain SBP

**Control temperature**
- Constant temperature 32°C – 36°C
- Sedation; control shivering

**Diagnosis**

Likely cardiac cause? — NO → Consider CT brain and/or CTPA

Likely cardiac cause? — YES → 12-lead ECG ST elevation?

12-lead ECG ST elevation? — YES → Coronary angiography ± PCI

12-lead ECG ST elevation? — NO → Consider Coronary angiography ± PCI

Coronary angiography ± PCI / Consider Coronary angiography ± PCI → Cause for cardiac arrest identified?

Cause for cardiac arrest identified? — NO → Consider CT brain and/or CTPA

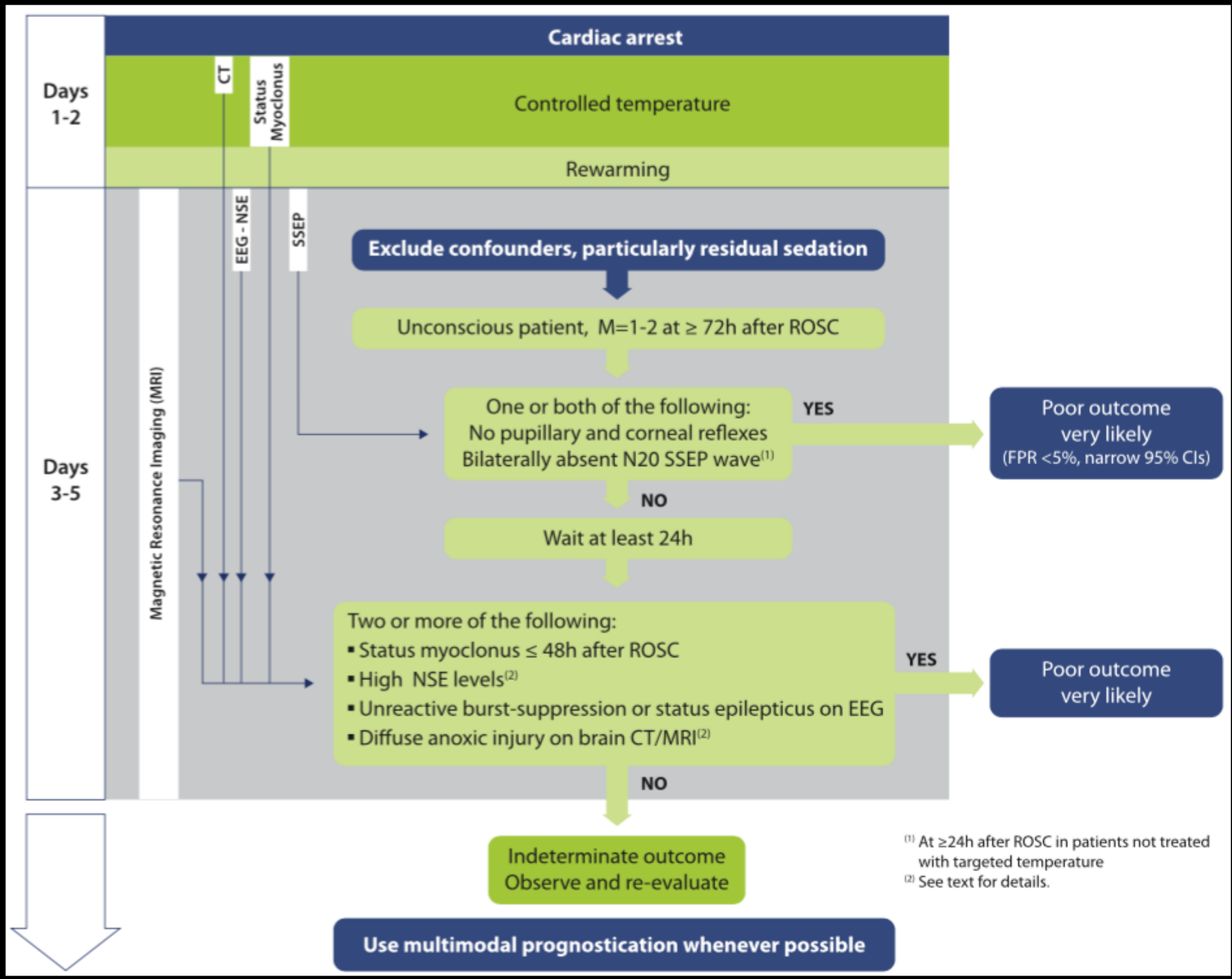
Consider CT brain and/or CTPA → Treat non-cardiac cause of cardiac arrest

Cause for cardiac arrest identified? — YES → Admit to Intensive Care Unit

**Optimising recovery**

**ICU management**
- Temperature control: constant temperature 32°C – 36°C for ≥ 24h; prevent fever for at least 72 h
- Maintain normoxia and normocapnia; protective ventilation
- Optimise haemodynamics (MAP, lactate, $ScvO_2$, CO/CI, urine output)
- Echocardiography
- Maintain normoglycaemia
- Diagnose/treat seizures (EEG, sedation, anticonvulsants)
- Delay prognostication for at least 72 h

**Secondary prevention**
e.g. ICD, screen for inherited disorders, risk factor management → **Follow-up and rehabilitation**




J.P. Nolan et al. / Resuscitation 95 (2015) 202–222


American Heart Association

# Part 8: Post–Cardiac Arrest Care 2015

American Heart Association Guidelines Update for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care

Clifton W. Callaway, Chair; Michael W. Donnino; Ericka L. Fink; Romergryko G. Geocadin; Eyal Golan; Karl B. Kern; Marion Leary; William J. Meurer; Mary Ann Peberdy; Trevonne M. Thompson; Janice L. Zimmerman

EUROPEAN RESUSCITATION COUNCIL

# Guidelines for Post-resuscitation Care 2015 Section 5

European Resuscitation Council Guidelines for Resuscitation 2015

Jerry P. Nolana,b,*, Jasmeet Soarc, Alain Carioud, Tobias Cronberge,
ue R.M. Moulaertf, Charles D. Deaking, Bernd W. Bottigerh, Hans Fribergi, Kjetil Sundej, Claudio San


# P. Safar
# 1964

**“Death is a protracted pathophysiological process, not a moment”**

JOURNAL OF IOWA MEDICAL SOCIETY

## HEART–LUNG RESUSCITATION

### I FIRST AID: OXYGENATE THE BRAIN IMMEDIATELY

1 or 2 operators

IF UNCONSCIOUS

**Airway** – *TILT HEAD BACK*

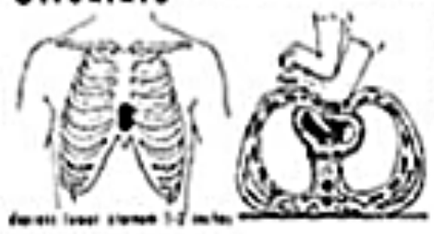
IF NOT BREATHING

**Breathe** – *INFLATE LUNGS 3-5 TIMES, MAINTAIN HEAD TILT*

mouth-to-mouth, mouth-to-nose, mouth-to-adjunct, bag-mask

- FEEL PULSE
- IF PRESENT – CONTINUE LUNG INFLATIONS
- IF ABSENT –

**Circulate** – *COMPRESS HEART ONCE A SECOND. ALTERNATE 2-3 LUNG INFLATIONS WITH 15 STERNAL COMPRESSIONS UNTIL SPONTANEOUS PULSE RETURNS.*



for physicians only

### II START SPONTANEOUS CIRCULATION

**Drugs** – *EPINEPHRINE:* 1.0 mg (1.0 CC OF 1/1000) I.V. OR 0.5 mg INTRACARDIAC. REPEAT LARGER DOSE IF NECESSARY

*SODIUM BICARBONATE:* APPROXIMATELY 3.75 G/50 CC (1/2 DOSE IN CHILDREN) I.V. REPEAT EVERY 5 MINUTES IF NECESSARY

**E. K. G.** – • *FIBRILLATION:* EXTERNAL ELECTRIC DEFIBRILLATION. REPEAT SHOCK EVERY 1-3 MINUTES UNTIL FIBRILLATION REVERSED

• *IF ASYSTOLE OR WEAK BEATS:* EPINEPHRINE OR CALCIUM I.V.

**Fluids** – *I.V. PLASMA, DEXTRAN, SALINE*

Do not interrupt cardiac compressions and ventilation. Tracheal intubation only when necessary.

AFTER RETURN OF SPONTANEOUS CIRCULATION USE VASOPRESSORS AS NEEDED.

e.g. NOREPINEPHRINE (Levophed) I.V. DRIP

### III SUPPORT RECOVERY (physician-specialist)

**Gauge** *EVALUATE AND TREAT CAUSE OF ARREST*

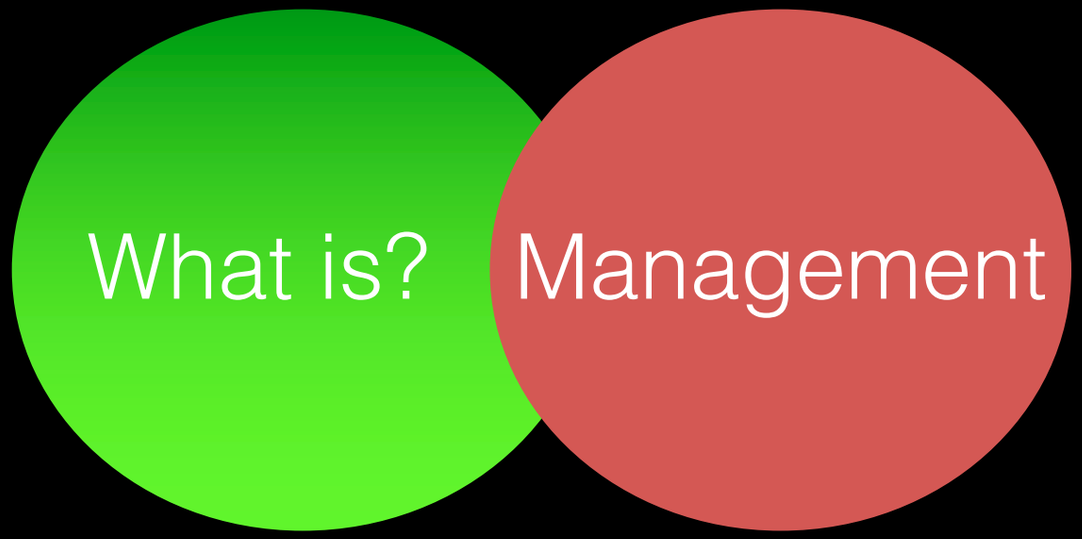
**Hypothermia** *START WITHIN 30 MINUTES IF NO SIGN OF CNS RECOVERY*

**Intensive Care** *SUPPORT VENTILATION:* TRACHEOTOMY, PROLONGED CONTROLLED VENTILATION, GASTRIC TUBE AS NECESSARY

*SUPPORT CIRCULATION*
*CONTROL CONVULSIONS*
*MONITOR*

Figure 1. The A, B, C of emergency resuscitation. These instructions have been arranged for the front and back of a billfold


# The post-cardiac arrest syndrome




- Myocardial Dysfunction (due to ischemia and stunning)
- Anoxic brain injury
- Ischemia and reperfusion syndrome
  (Sistemic inflammatorie response " a sepsis like syndrome")
- Persistent precipitating pathology

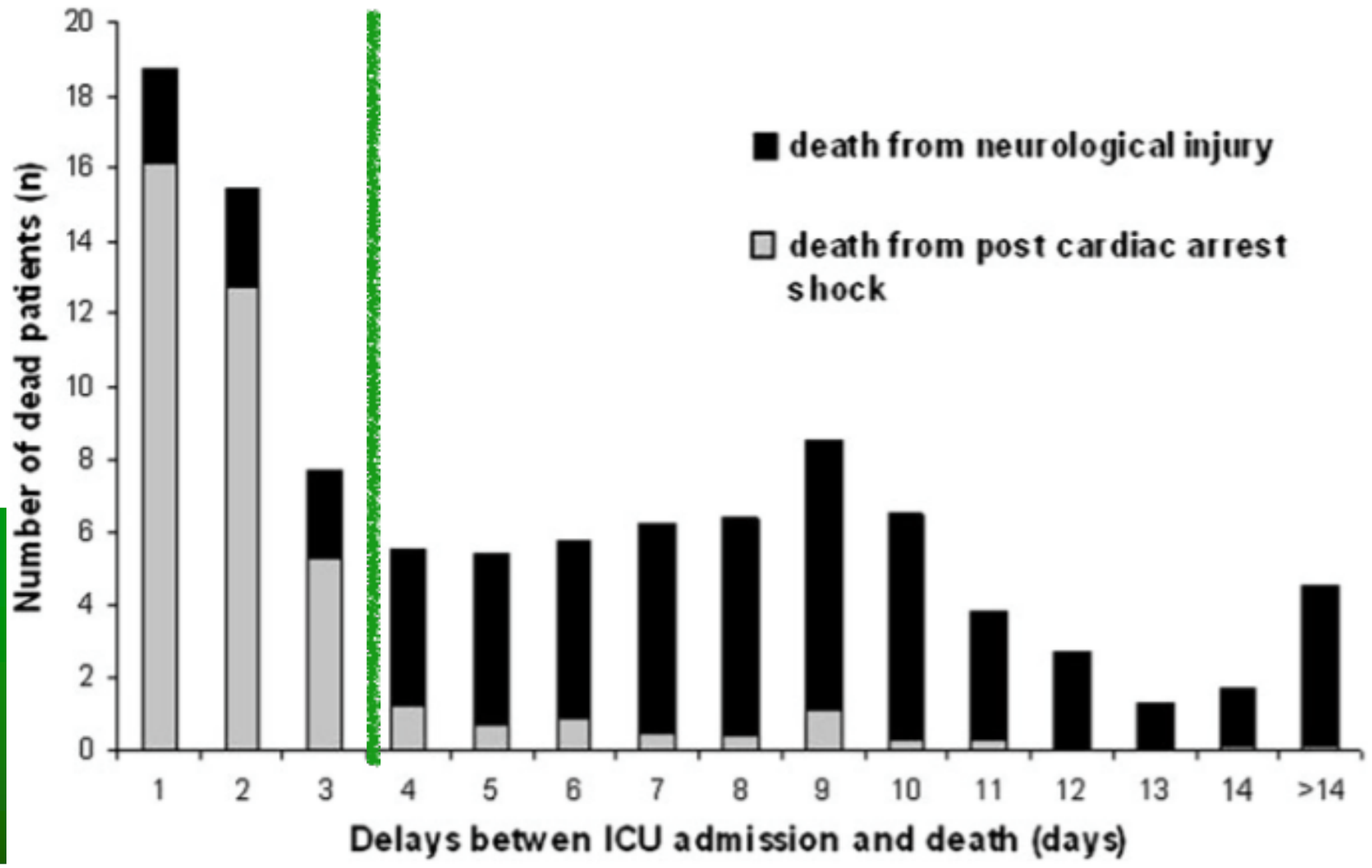
Intensive Care Med (2013) 39:1972–1980
DOI 10.1007/s00134-013-3043-4

ORIGINAL

Virginie Lemiale
Florence Dumas
Nicolas Mongardon
Olivier Giovanetti
Julien Charpentier

# Intensive care unit mortality after cardiac arrest: the relative contribution of shock and brain injury in a large cohort

**Fig. 2** Mode of death according to the delay between ICU admission and death




**During the ICU stay, 269 (34.8%) patients died from post-CA shock and 499 (65.2%) from neurological injury.**

**Myocardial stunning is defined as postischemic dysfunction of myocytes that have not undergone irreversible cell injury**

Resuscitation. 2005 Aug;66(2):175-81.
Reversible myocardial dysfunction after cardiopulmonary resuscitation.
Ruiz-Bailén M  Aguayo de Hoyos E et al.

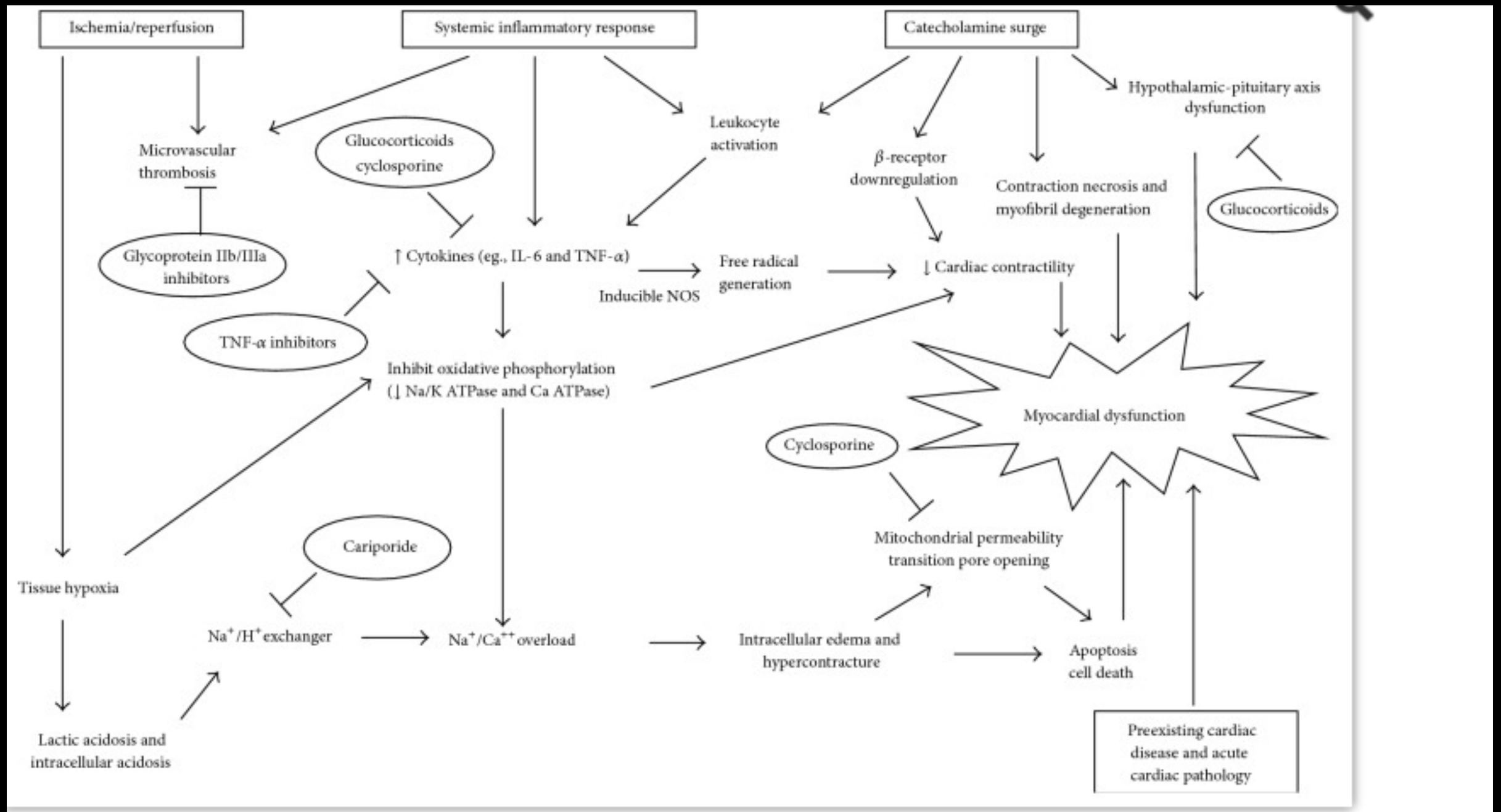
Biomed Res Int. 2015;2015:314796. doi: 10.1155/2015/314796. Epub 2015 Sep 2.

# Myocardial Dysfunction and Shock after Cardiac Arrest.

Jentzer JC[1], Chonde MD[2], Dezfulian C[3].

Incidence of left ventricular systolic dysfunction in adult survivors of cardiac arrest. LVEF = left ventricular ejection fraction, LVSD = left ventricular systolic dysfunction (LVEF < 50–60%), and NR = not reported.

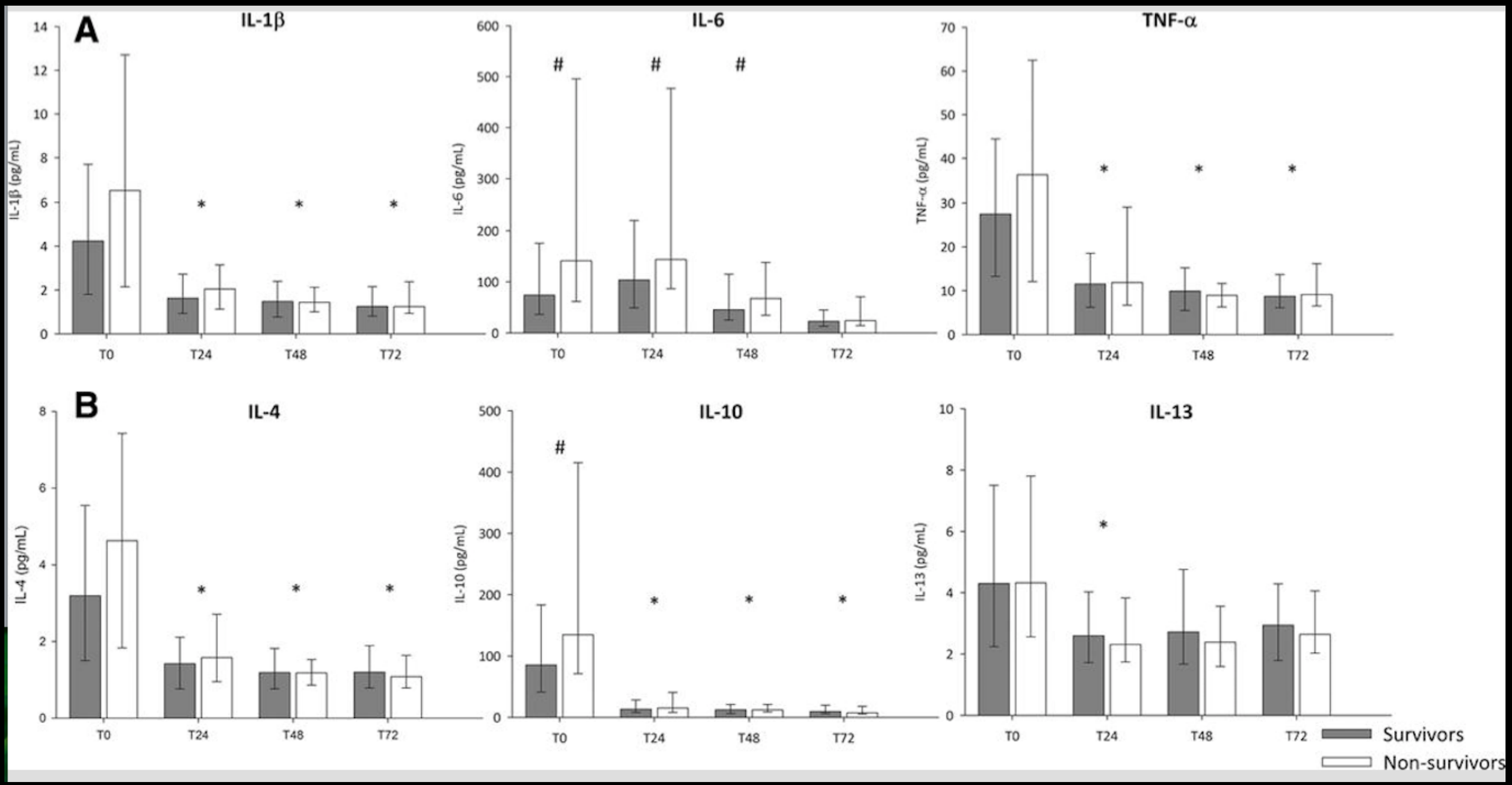
| Study | Year | Number of patients | % LVSD | Mean LVEF |
|---|---|---|---|---|
| Laurent et al. [14] | 2002 | 148 | NR | 37.6% |
| Ruiz-Bailén et al. [15] | 2005 | 29 | 69% | 42% |
| Chang et al. [17] | 2007 | 58 | NR | 53.7% |
| Gonzalez et al. [8] | 2008 | 84 | NR | 32% |
| Gaieski et al. [18] | 2009 | 22 | NR | 36.9% |
| Dumas et al. [16] | 2012 | 308 | 72% | NR |
| Bro-Jeppesen et al. [20] | 2014 | 154 | NR | 37% |
| Bro-Jeppesen et al. [21] | 2015 | 523 | 75% | NR |
| Ameloot et al. [19] | 2015 | 82 | NR | 42% |


Ischemia/reperfusion
Systemic inflammatory response
Catecholamine surge
Microvascular thrombosis
Glucocorticoids cyclosporine
Leukocyte activation
β-receptor downregulation
Hypothalamic-pituitary axis dysfunction
Contraction necrosis and myofibril degeneration
Glucocorticoids
Glycoprotein IIb/IIIa inhibitors
↑ Cytokines (eg., IL-6 and TNF-α)
Free radical generation
Inducible NOS
↓ Cardiac contractility
TNF-α inhibitors
Inhibit oxidative phosphorylation (↓ Na/K ATPase and Ca ATPase)
Myocardial dysfunction
Cyclosporine
Cariporide
Mitochondrial permeability transition pore opening
Tissue hypoxia
Na+/H+ exchanger
Na+/Ca++ overload
Intracellular edema and hypercontracture
Apoptosis cell death
Lactic acidosis and intracellular acidosis
Preexisting cardiac disease and acute cardiac pathology

Crit Care Med. 2015 Jun;43(6):1223-32. doi: 10.1097/CCM.0000000000000937.

# Systemic Inflammatory Response and Potential Prognostic Implications After Out-of-Hospital Cardiac Arrest: A Substudy of the Target Temperature Management Trial.

Bro-Jeppesen J[1], Kjaergaard J, Wanscher M, Nielsen N, Friberg H, Bjerre M, Hassager C.



Levels of IL-6 and IL-10 at baseline correlated strongly with variables reflecting the magnitude of the ischemic event: dose of administered adrenaline, time to ROSC, and initial lactate. Furthermore, lev- els of IL-6 and IL-10 were associated with time to ROSC and presence of shock at admission. High IL-6 levels at baseline and high levels of IL-6 and procalcitonin 24 hours after OHCA were associated with increased 30-day mortality

The post-cardiac arrest syndrome
is a distinct and more complex
entity than a sepsis-like syndrome

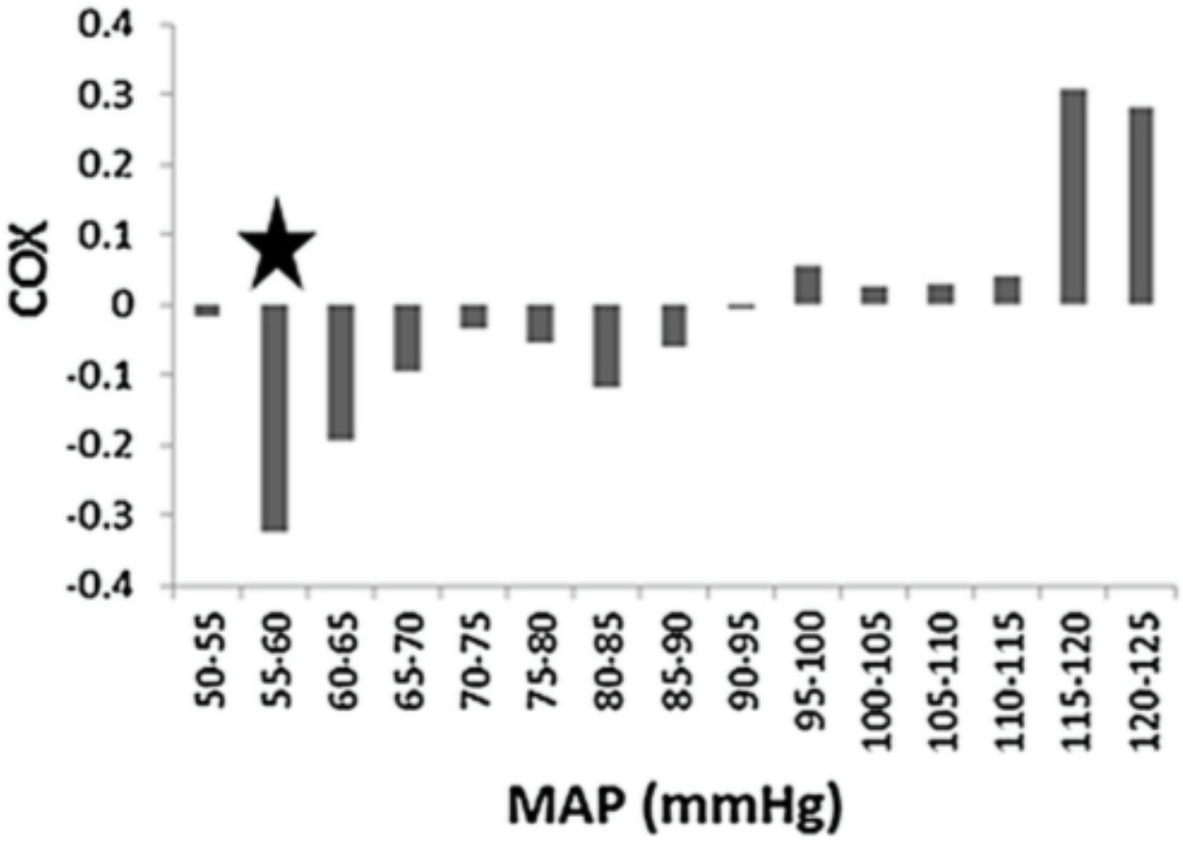
Clinical Paper

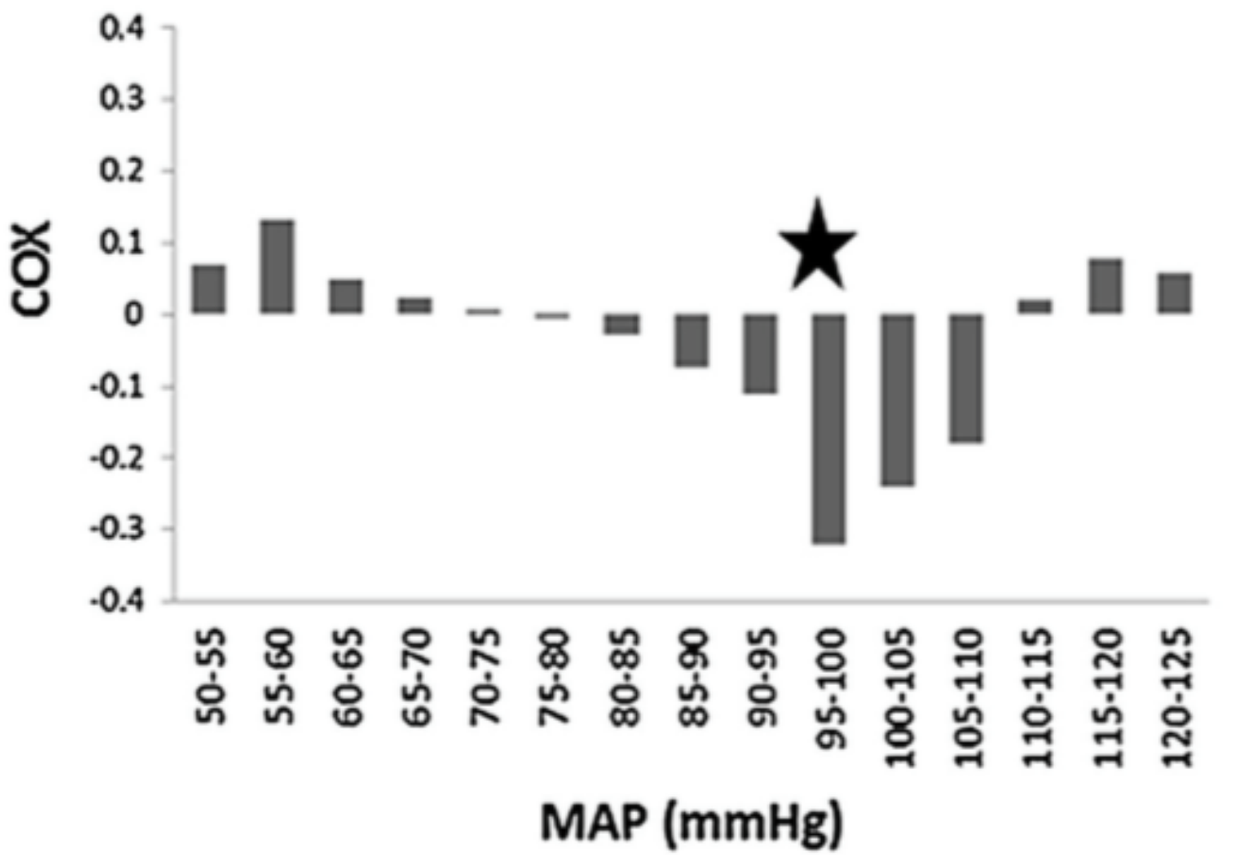
# An observational near-infrared spectroscopy study on cerebral autoregulation in post-cardiac arrest patients: Time to drop 'one-size-fits-all' hemodynamic targets?☆

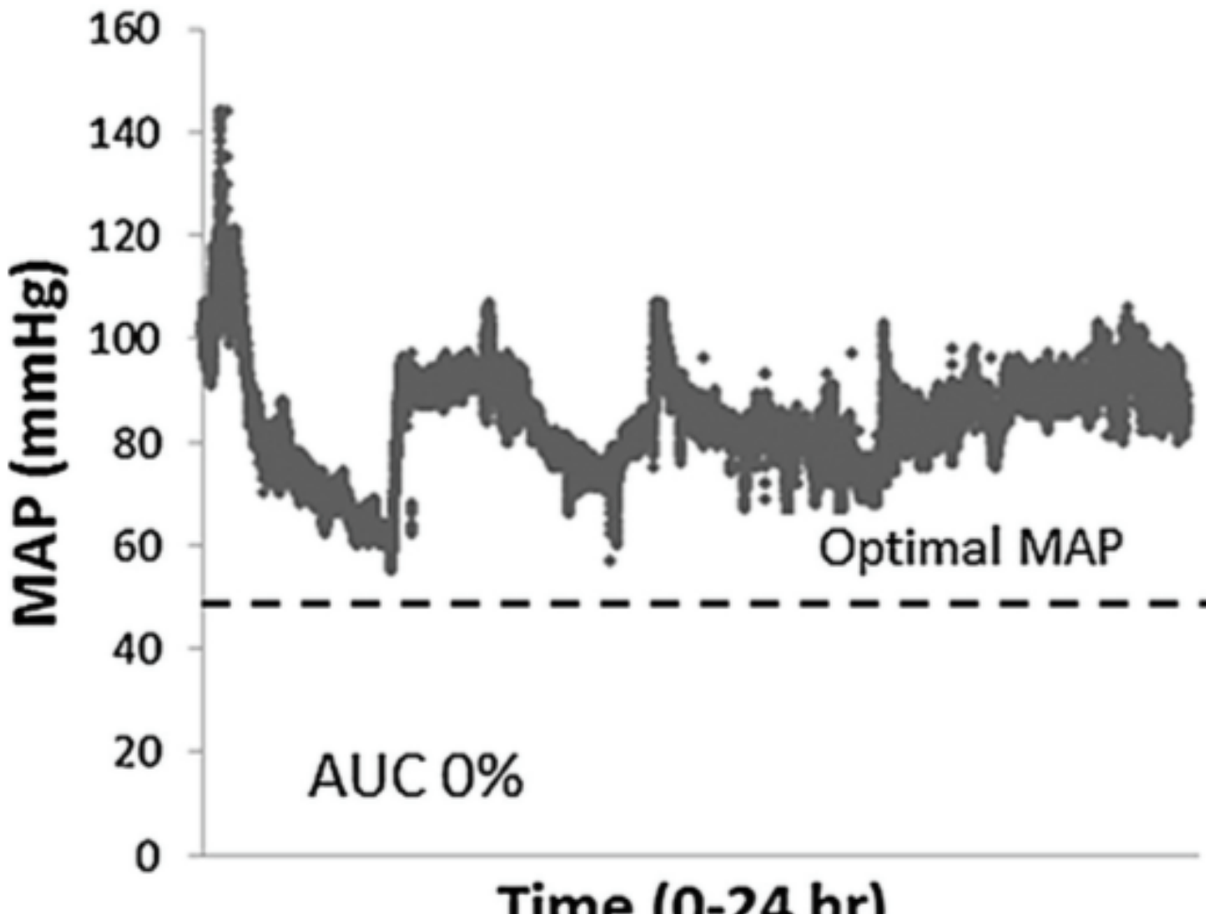
K. Ameloot[a,*,1], C. Genbrugge[b,c,1], I. Meex[b,c], F. Jans[b,c], W. Boer[b], M. Vander Laenen[b], B. Ferdinande[a], W. Mullens[a,c], M. Dupont[a], J. Dens[a,c], C. DeDeyne[b,c]

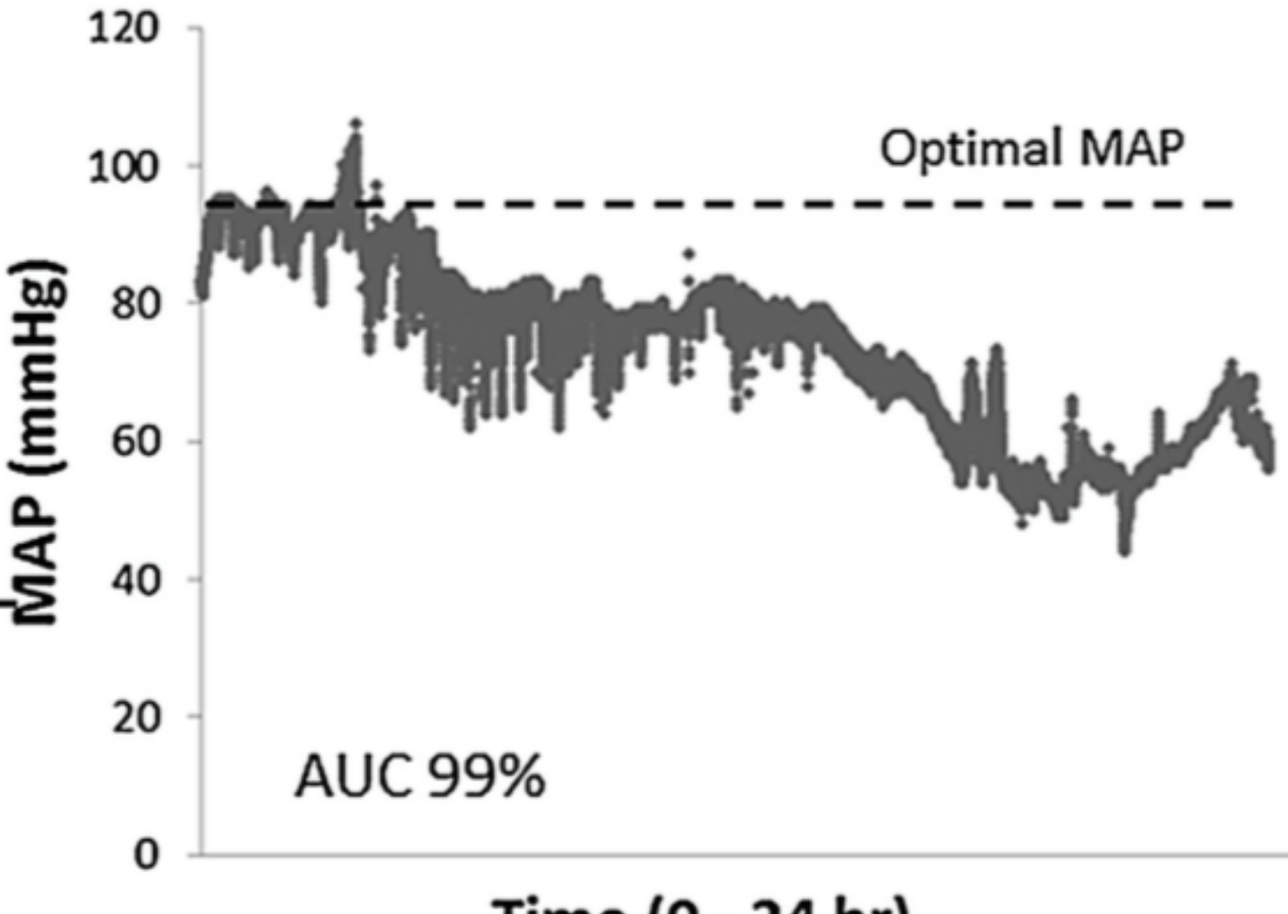
Resuscitation 90 (2015) 121–126

In summary, cerebral autoregulation is disturbed, probably right-shifted in about one third of post-CA patients of which a majority had pre-CA hypertension. These patients have a worse prognosis as they are at risk for cerebral hypoperfusion when resuscitated to uniform hemodynamic targets and have worse prognosis.


0.4
0.3
0.2
0.1
0
-0.1
-0.2
-0.3
-0.4
COX
50-55
55-60
60-65
65-70
70-75
75-80
80-85
85-90
90-95
95-100
100-105
105-110
110-115
115-120
120-125
MAP (mmHg)

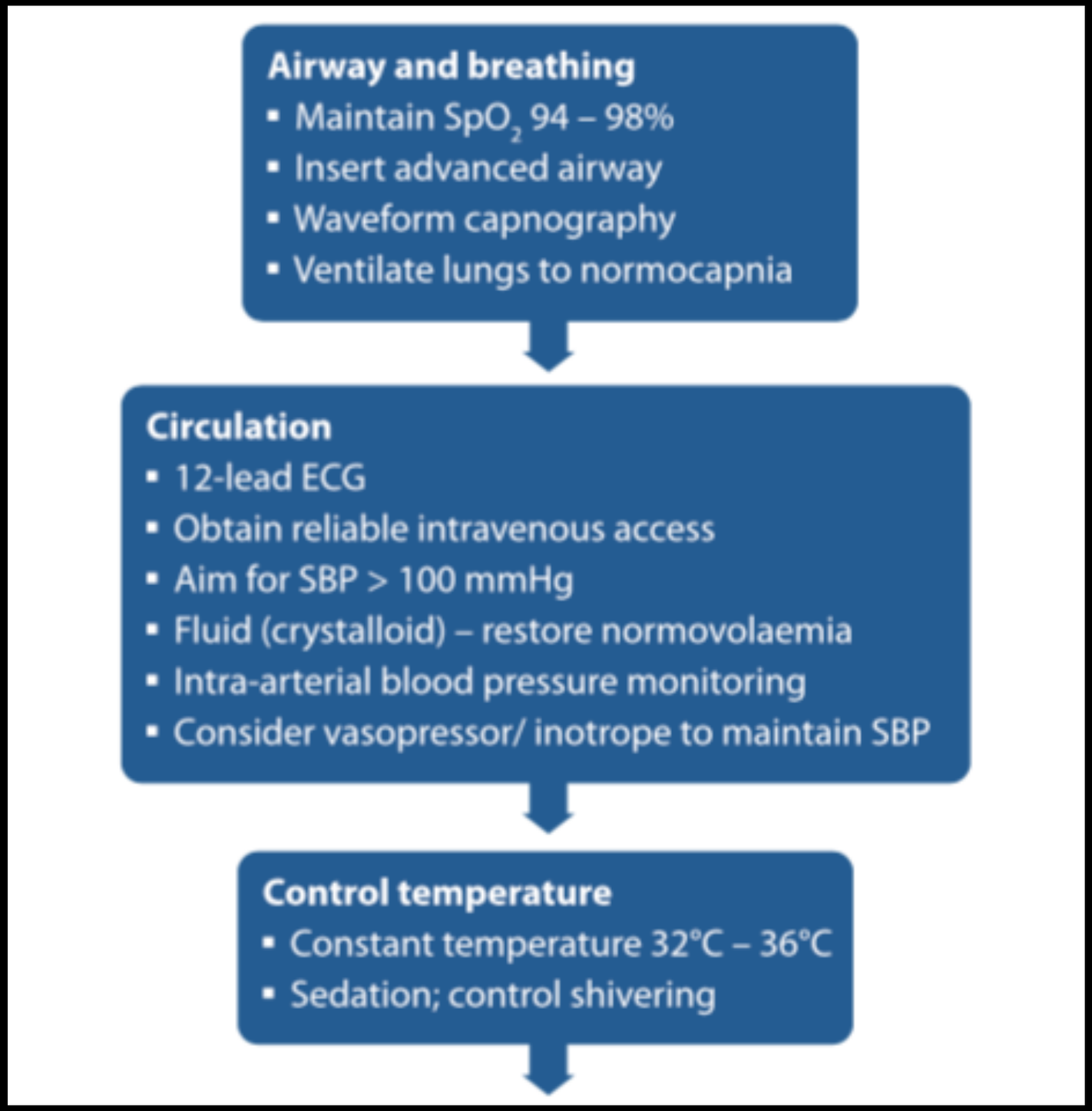

0.4
0.3
0.2
0.1
0
-0.1
-0.2
-0.3
-0.4
COX
50-55
55-60
60-65
65-70
70-75
75-80
80-85
85-90
90-95
95-100
100-105
105-110
110-115
115-120
120-125
MAP (mmHg)


160
140
120
100
80
60
40
20
0
MAP (mmHg)
Optimal MAP
AUC 0%
Time (0-24 hr)


120
100
80
60
40
20
0
MAP (mmHg)
Optimal MAP
AUC 99%
Time (0 - 24 hr)

# Return of spontaneous circulation and comatose

## 1° Immediate treatment




AIRWAY

CIRCULATION

TTM

# The Effects of Oxygenation and CO2 on Outcome after Cardiac Arrest

.Y Sutherasan, M Vargas, I Brunetti, et al. Minerva anestesiologica 81 (1), 2014

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- In Adults

✓ Hypoxia (<60 mmHg) and Hyperoxia (>200 mmHg) were associated with increased mortality

✓ Hypocapnia (<30 mmHg) was associated with worse neurologic outcome

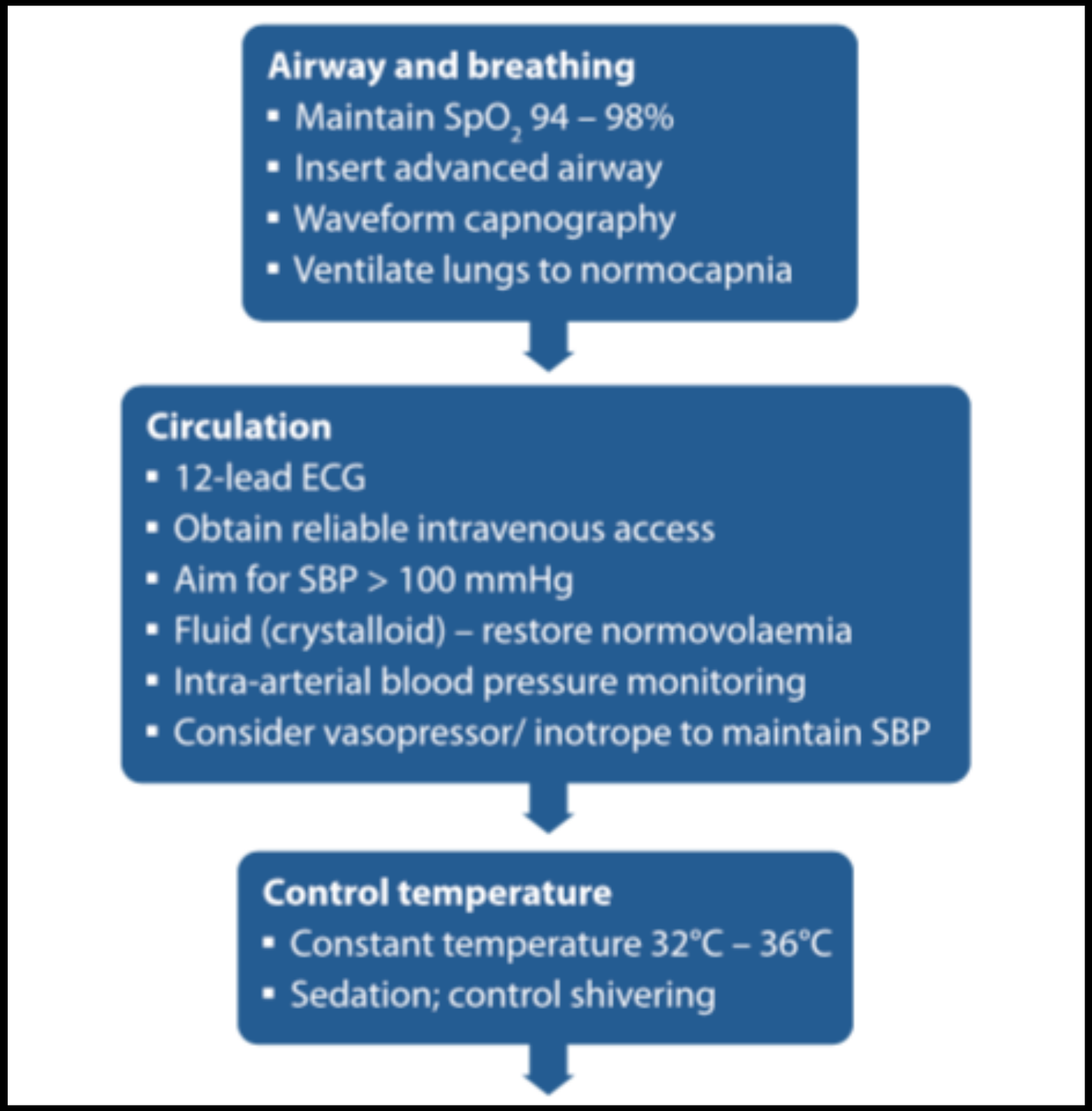
- In Pediatrics

✓ Hypoxia (<60 mmHg) and Hyperoxia (>200 mmHg) were NOT associated with higher mortality

✓ Hypocapnia (<30 mmHg) and Hypercarbia (>50 mmHg) were associated with increased mortality and worse neurologic outcome

# Return of spontaneous circulation and comatose

## 1° Immediate treatment




AIRWAY

CIRCULATION

TTM

**Jentzer JC, et al. Myocardial Dysfunction and Shock after Cardiac Arrest. *BioMed***

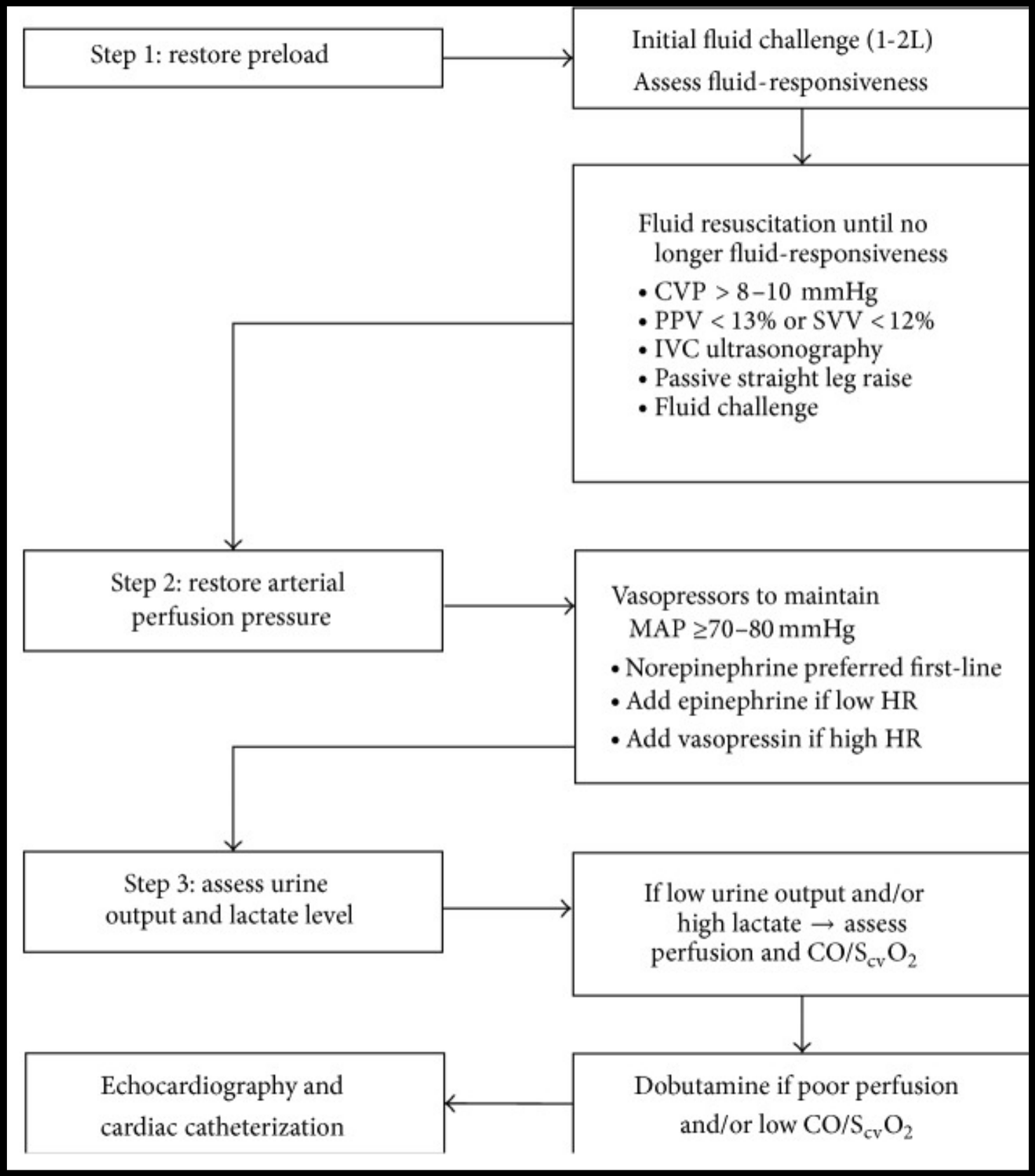
Restore preload

Restore PPA

Assess urine output
Assess lactate level

Imaging

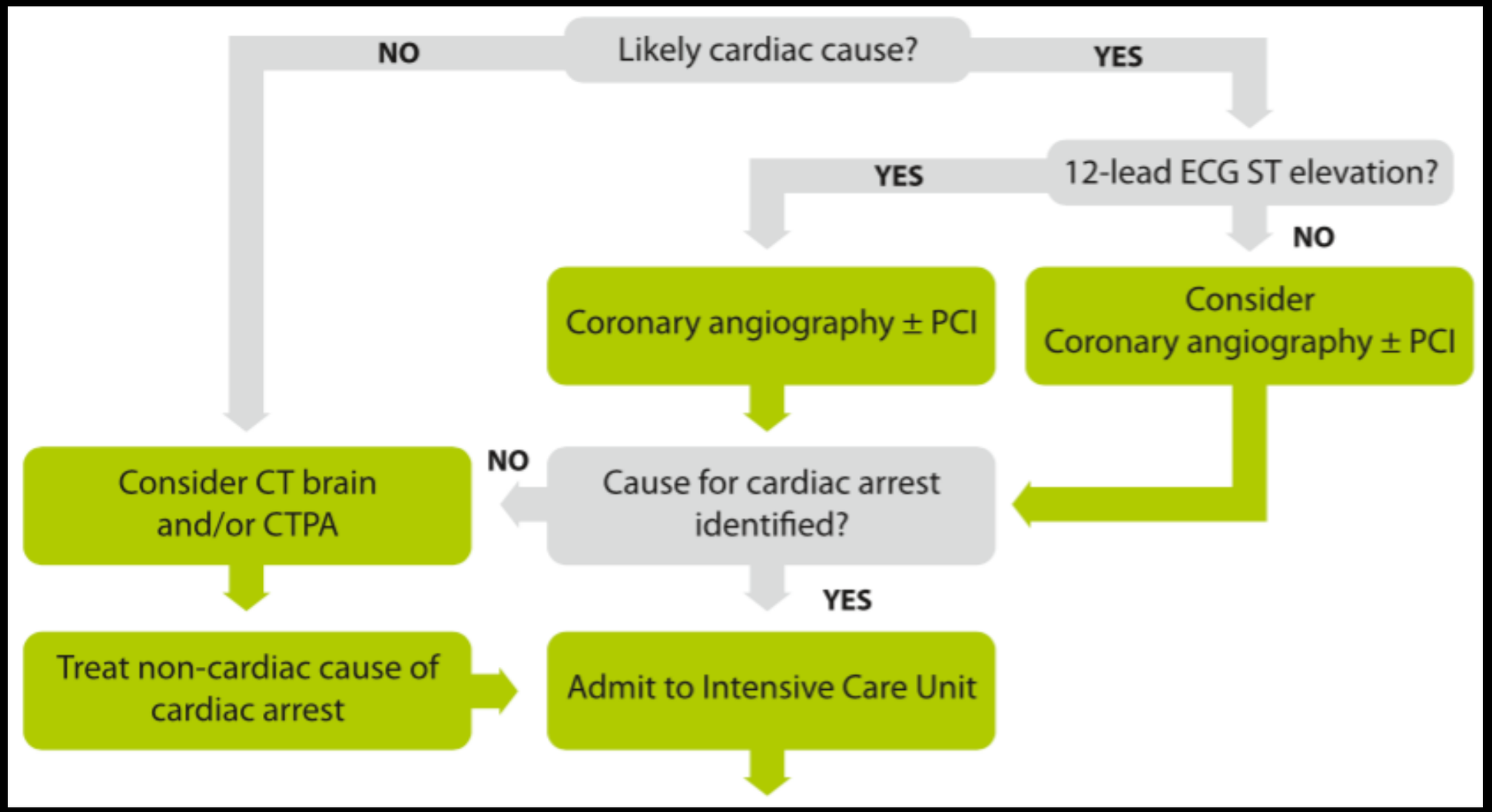
Invasive monitoring




***Avoiding and immediately correcting hypotension (systolic blood pressure less than 90 mm Hg, MAP***

# Return of spontaneous circulation and comatose

## 2° Diagnosis



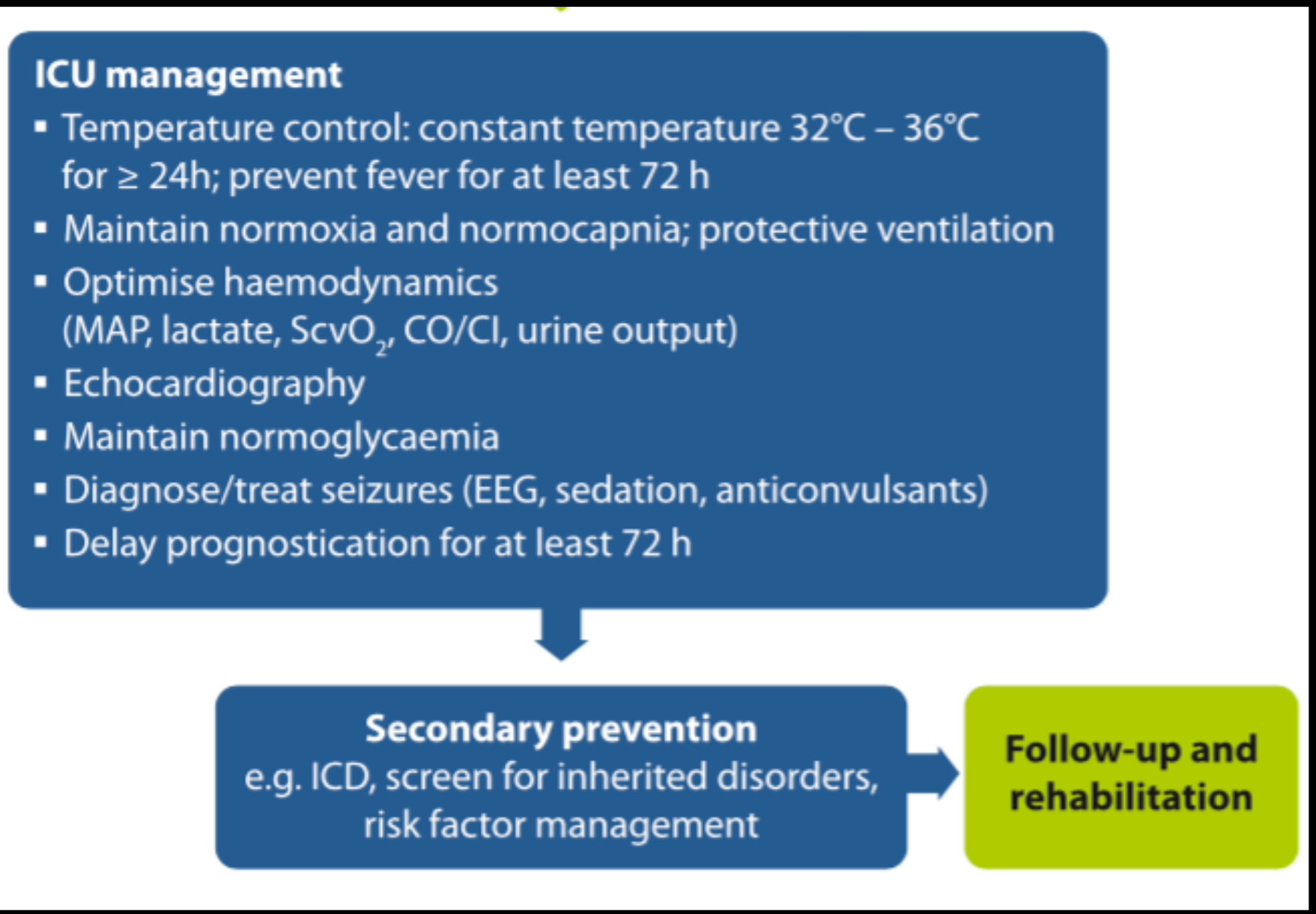

12 lead ECG

Angiography?

CT brain?

# Return of spontaneous circulation and comatose

## 3° Optimising recovery



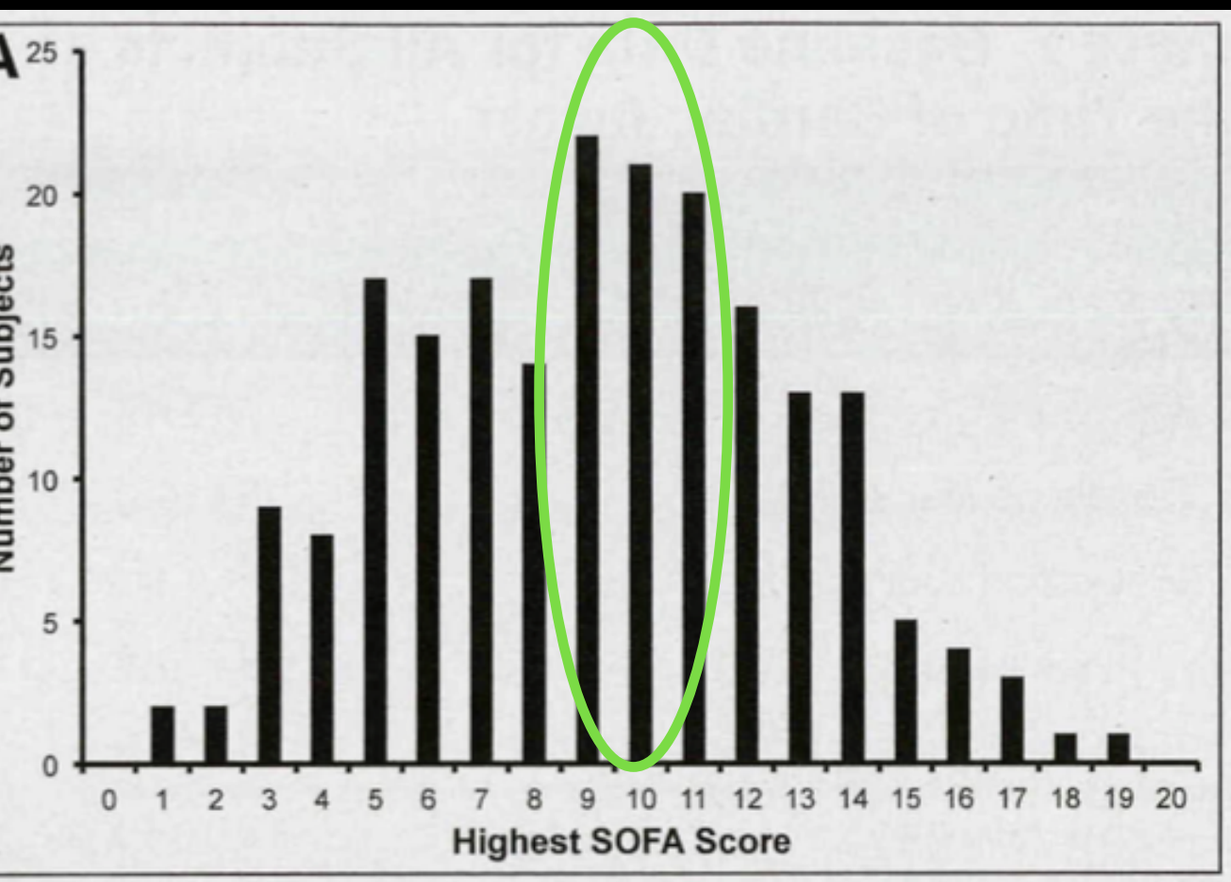

ICU management

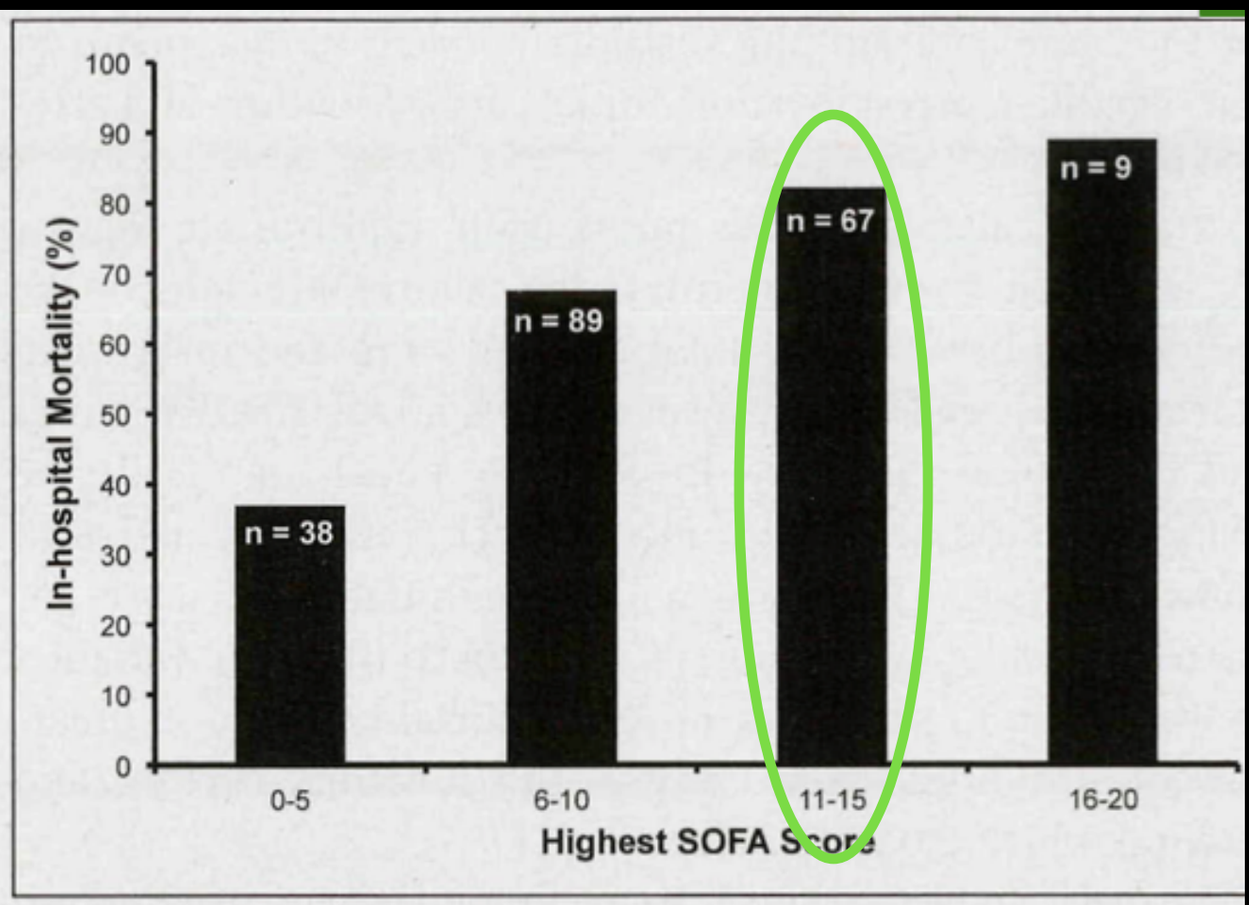
Follow up

Crit Care Med. 2013 Jun;41(6):1492-501. doi: 10.1097/CCM.0b013e31828a39e9.

# Multiple organ dysfunction after return of spontaneous circulation in postcardiac arrest syndrome.

Roberts BW[1], Kilgannon JH, Chansky ME, Mittal N, Wooden J, Parrillo JE, Trzeciak S.



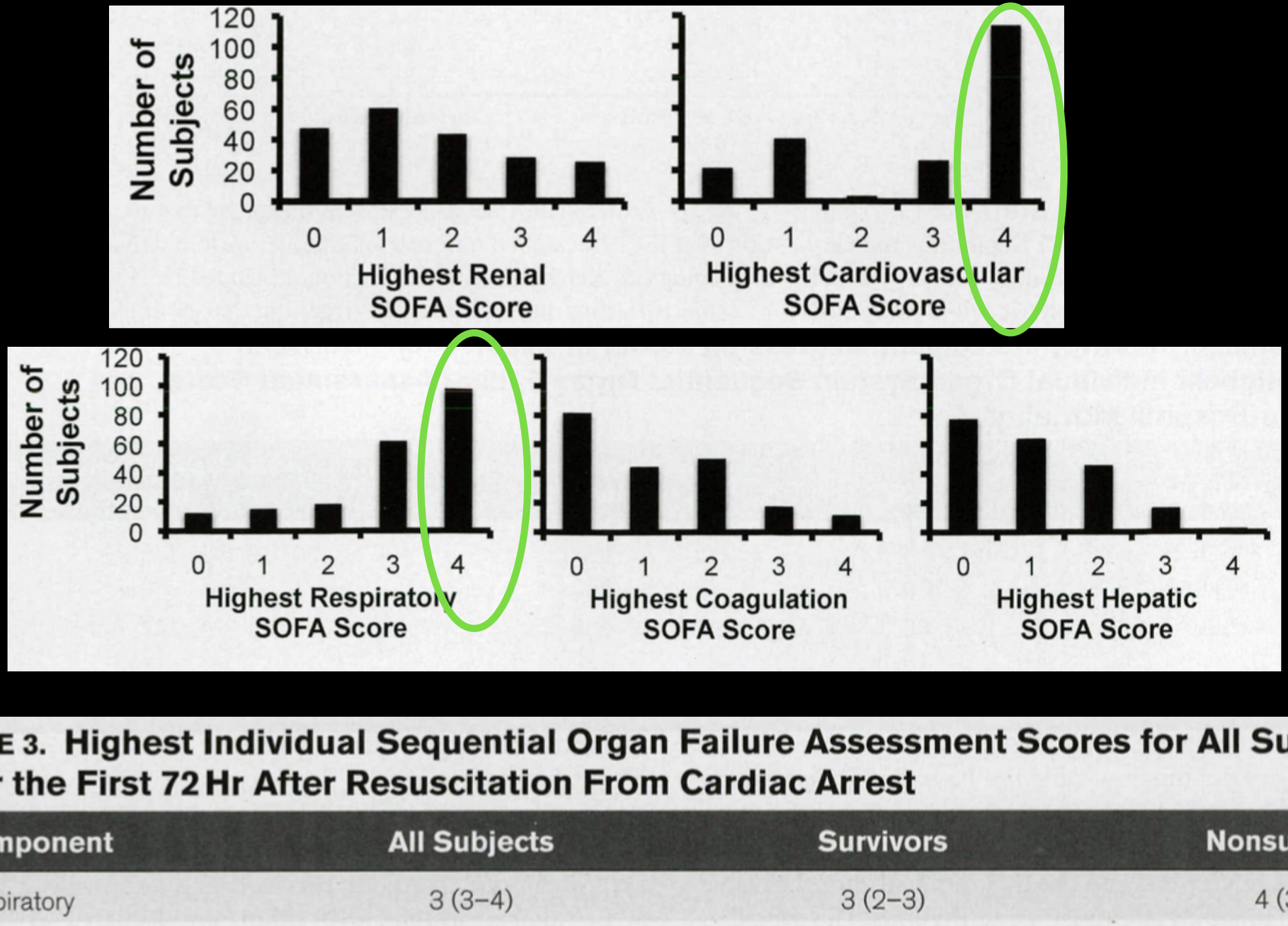



**TABLE 3. Highest Individual Sequential Organ Failure Assessment Scores for All Subjects Over the First 72 Hr After Resuscitation From Cardiac Arrest**

| Component | All Subjects | Survivors | Nonsurvivors |
|---|---|---|---|
| Respiratory | 3 (3–4) | 3 (2–3) | 4 (3–4) |
| Coagulation | 1 (0–2) | 1 (0–2) | 1 (0–2) |
| Hepatic | 1 (0–2) | 1 (0–2) | 1 (0–2) |
| Renal | 1 (1–3) | 1 (0–2) | 1 (1–3) |
| Cardiovascular | 4 (1–4) | 1 (1–4) | 4 (3–4) |

All values are displayed as median (interquartile range).

# How to prevent further lung injury (1)

- **Apply protective ventilation after cardiac arrest**



- avoid from high tidal volume (VT) and driving pressures
- avoid repeated recruitment and derecruitment of unstable lung units
- avoid peripheral airway collapse at low end expiratory lung volume and cyclic open and closing of peripheral airway
- avoid biotrauma, particularly in the extracellular matrix

# How to prevent further lung injury (2)

**$V_T$ 6 – 8 ml/Kg PBW**

**PEEP 5 – 6 mmHg**

**$SO_2$ c target 94 – 98 % (88 – 92% in COPD )**

**$PaO_2$ 80 – 150 mmHg**

**Monitoring $ETCO_2$**

**$PaCO_2$ 35 – 45 mmHg ( 35 – 50 mmHg could be evalued in absence of intracranial lesions)**

**Insert NGS and keep head raised at 30° – 35°**

# Prognostication

# Grazie!

brunettimed@gmail.com