POST RESUSCITATION CARE

2ο ΚΛΙΝΙΚΟ ΦΡΟΝΤΙΣΤΗΡΙΟ

ΚΑΡΔΙΟΑΝΑΠΝΕΥΣΤΙΚΗΣ ΑΝΑΖΩΟΓΟΝΗΣΗΣ

4, 5, 6 ΝΟΕΜΒΡΙΟΥ 2022

EUROPEAN RESUSCITATION COUNCIL

GUIDELINES 2021

ΚΑΝΑΒΟΥ ΑΓΓΕΛΙΚΗ
ΠΑΘΟΛΟΓΟΣ- ΕΝΤΑΤΙΚΟΛΟΓΟΣ
ΕΠΙΜΕΛΗΤΡΙΑ Α΄ΜΕΘ

The topics…

after ROSC

The topics…

- post-cardiac arrest syndrome
- diagnosis of cause of cardiac arrest
- control of oxygenation and ventilation
- coronary reperfusion
- haemodynamic monitoring and management
- control of seizures
- temperature control
- general intensive care management
- prognostication
- long-term outcome
- rehabilitation
- organ donation

POST-RESUSCITATION CARE

EUROPEAN RESUSCITATION COUNCIL GUIDELINES 2021

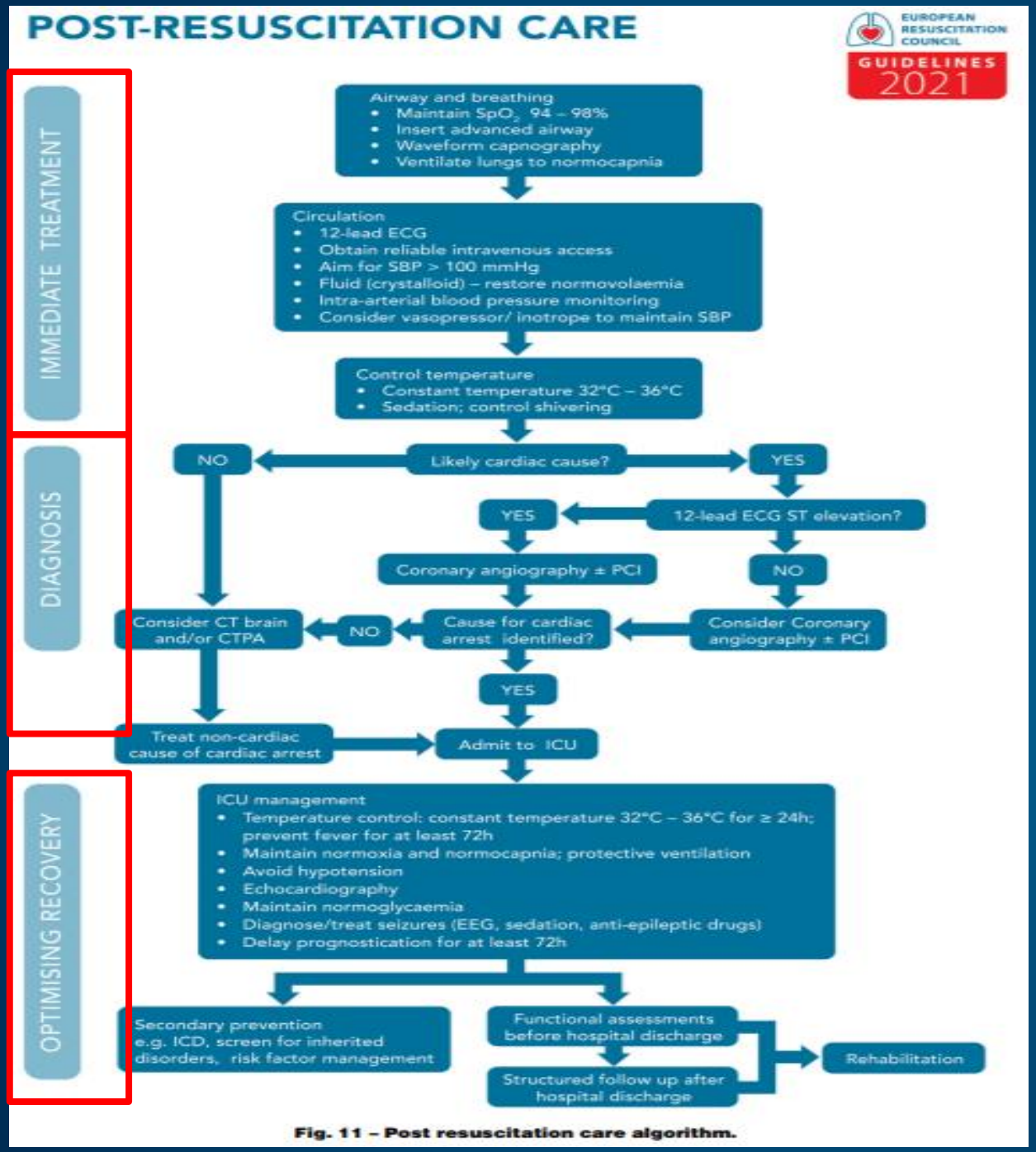

Fig. 11 – Post resuscitation care algorithm.

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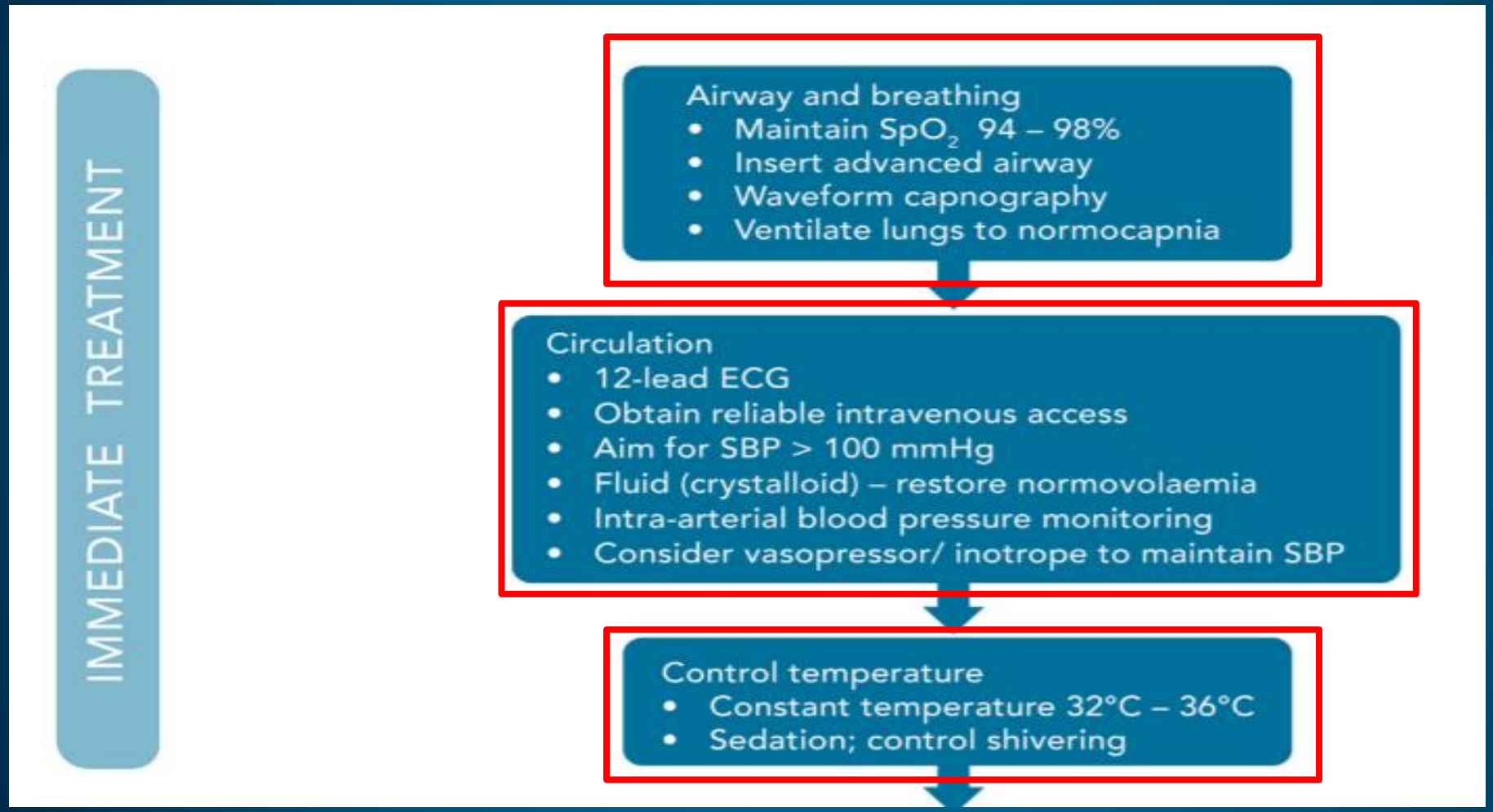
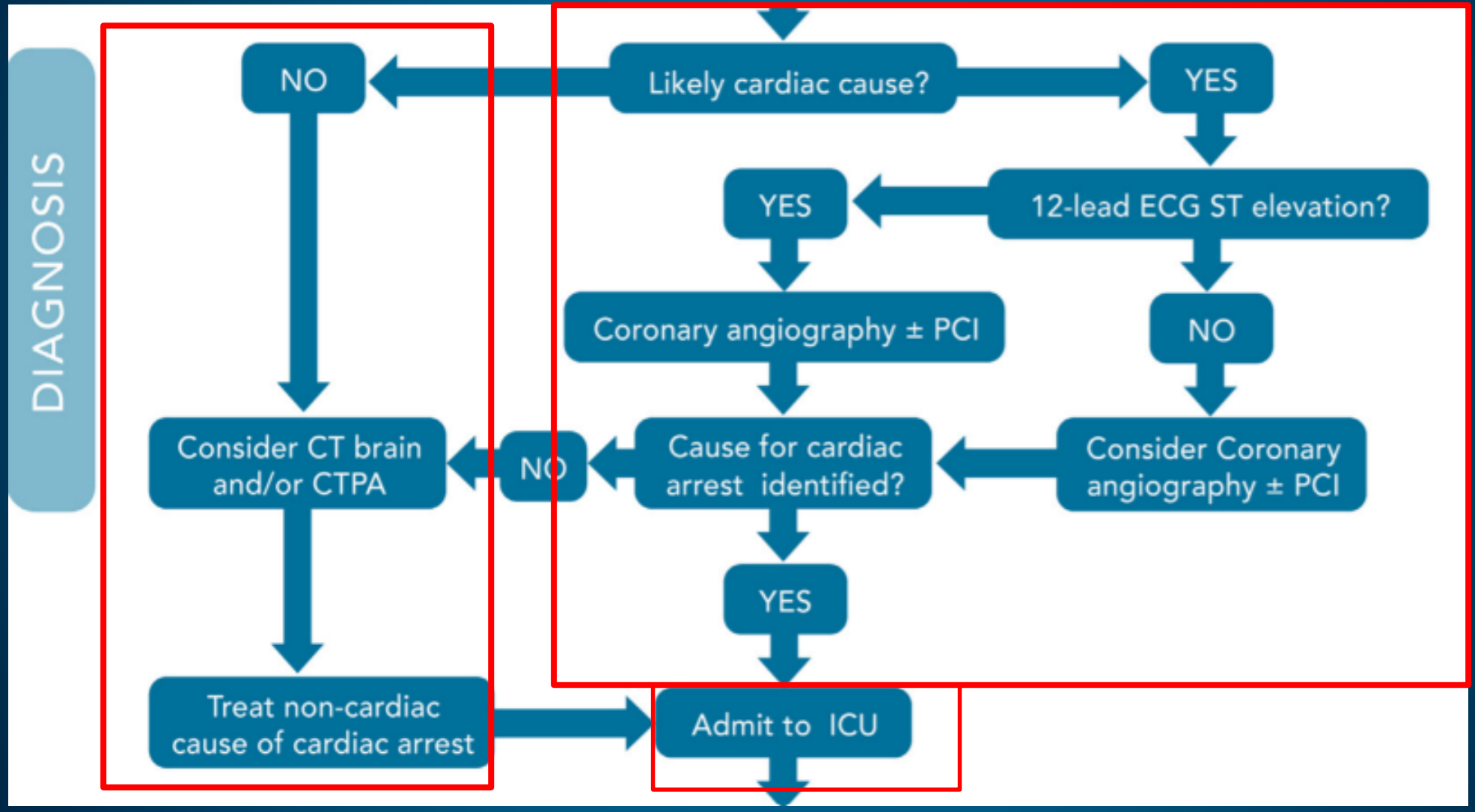
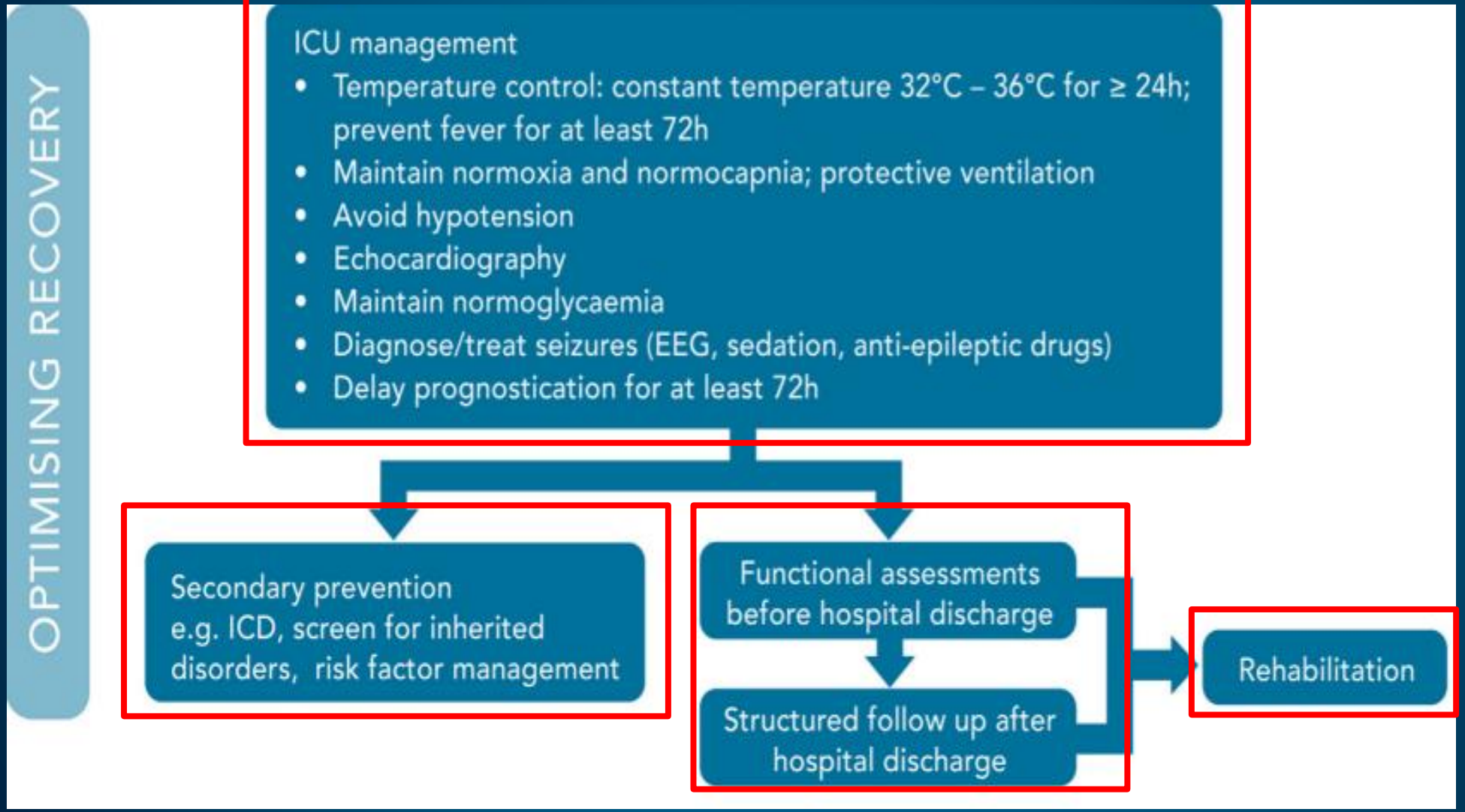
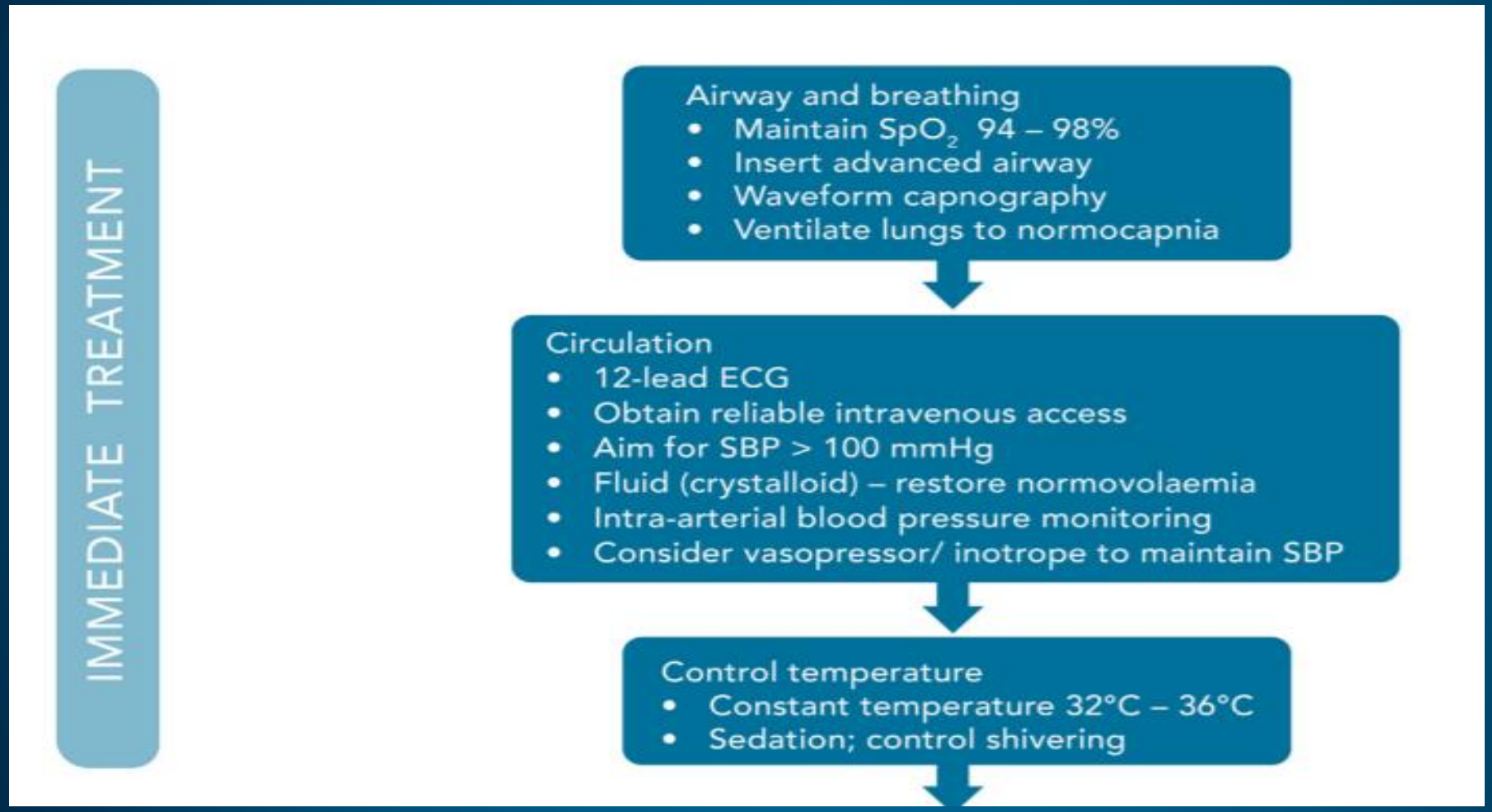

IMMEDIATE TREATMENT
Airway and breathing
• Maintain SpO_2 94 – 98%
• Insert advanced airway
• Waveform capnography
• Ventilate lungs to normocapnia
Circulation
• 12-lead ECG
• Obtain reliable intravenous access
• Aim for SBP > 100 mmHg
• Fluid (crystalloid) – restore normovolaemia
• Intra-arterial blood pressure monitoring
• Consider vasopressor/ inotrope to maintain SBP
Control temperature
• Constant temperature 32°C – 36°C
• Sedation; control shivering

2


DIAGNOSIS
Likely cardiac cause?
NO
YES
12-lead ECG ST elevation?
YES
NO
Coronary angiography ± PCI
Consider Coronary angiography ± PCI
Cause for cardiac arrest identified?
NO
Consider CT brain and/or CTPA
YES
Admit to ICU
Treat non-cardiac cause of cardiac arrest


OPTIMISING RECOVERY
ICU management
• Temperature control: constant temperature 32°C – 36°C for ≥ 24h; prevent fever for at least 72h
• Maintain normoxia and normocapnia; protective ventilation
• Avoid hypotension
• Echocardiography
• Maintain normoglycaemia
• Diagnose/treat seizures (EEG, sedation, anti-epileptic drugs)
• Delay prognostication for at least 72h
Secondary prevention
e.g. ICD, screen for inherited disorders, risk factor management
Functional assessments before hospital discharge
Structured follow up after hospital discharge
Rehabilitation

1


IMMEDIATE TREATMENT
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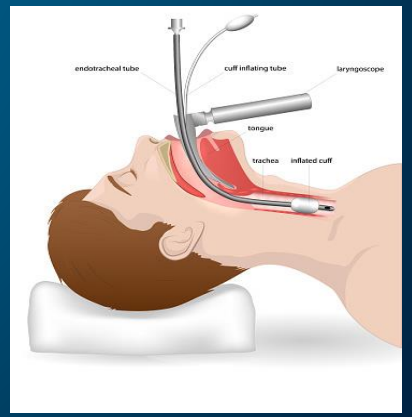
• Consider vasopressor/ inotrope to maintain SBP
Control temperature
• Constant temperature 32°C – 36°C
• Sedation; control shivering

Airway and breathing

- Airway and ventilation support should continue after return of spontaneous circulation (ROSC) is achieved.

- Patients who have had a brief period of cardiac arrest and an immediate return of normal cerebral function and are breathing normally may not require tracheal intubation but should be given oxygen via a facemask if their arterial blood oxygen saturation is less than 94%.

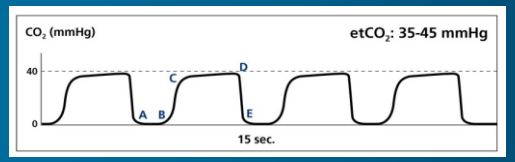
- Patients who remain comatose following ROSC, or who have another clinical indication for sedation and mechanical ventilation, should have their trachea intubated if this has not been done already during CPR.



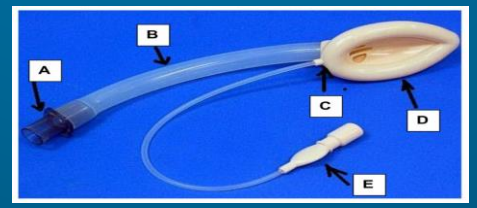
Airway and breathing

- Tracheal intubation should be performed only by experienced operators who have a high success rate.

- Correct placement of the tracheal tube must be confirmed with waveform capnography.

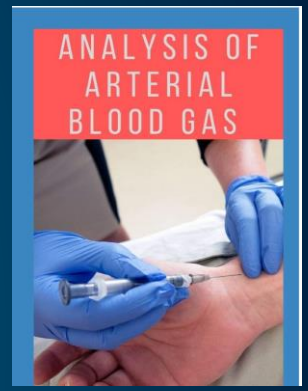


- In the absence of personnel experienced in tracheal intubation, it is reasonable to insert a supraglottic airway (SGA) or maintain the airway with basic techniques until skilled intubators are available.



Control of oxygenation

- After ROSC, use 100% (or maximum available) inspired oxygen until the arterial oxygen saturation or the partial pressure of arterial oxygen can be measured reliably.



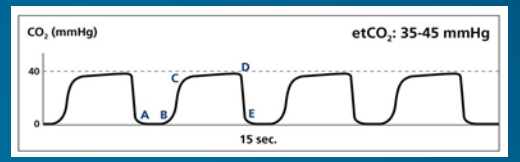
- After ROSC, once SpO2 can be measured reliably or arterial blood gas values are obtained, titrate the inspired oxygen to achieve an arterial oxygen saturation (SpO2)of 94-98% or arterial partial pressure of oxygen (PaO2) of 75-100mmHg

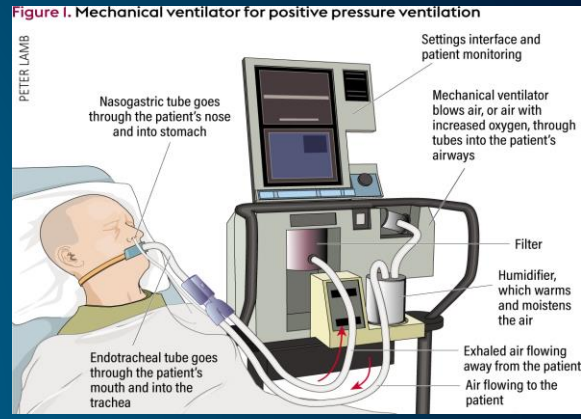
- Avoid hypoxaemia (PaO2<8 kPa or 60 mmHg) following ROSC.

- Avoid hyperoxaemia following ROSC

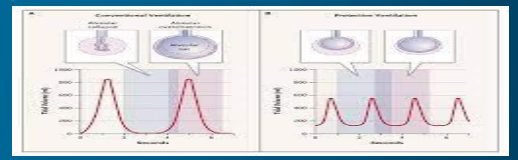
Control of ventilation

- Obtain an arterial blood gas and use end tidal CO2 in mechanically ventilated patients.





- Use a lung protective ventilation strategy aiming for a tidal volume of 6- 8mL/kg ideal body weight.

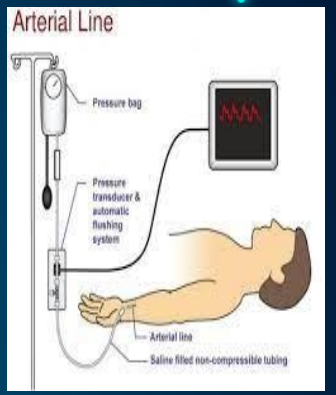


- In patients treated with targeted temperature management (TTM) monitor PaCO2 frequently as hypocapnia may occur.

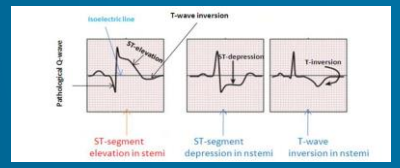
- During TTM and lower temperatures use consistently either a temperature or non-temperature corrected approach for measuring blood gas values.

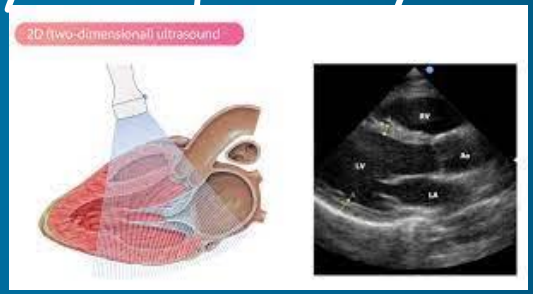
Haemodynamic monitoring and management

- All patients should be monitored with an arterial line for continuous blood pressure measurements, and it is reasonable to monitor cardiac output in haemodynamically unstable patients.



- Perform early (as soon as possible) echocardiography in all patients to detect any underlying cardiac pathology and quantify the degree of myocardial dysfunction.





- Avoid hypotension (<65 mmHg). Target mean arterial pressure (MAP) to achieve adequate urine output (>0.5mL/kg/h) and normal or decreasing lactate

MAP
UO
LAC

- During TTM at 33° C, bradycardia may be left untreated if blood pressure, lactate, ScvO2 or SvO2 is adequate. If not, consider increasing the target temperature, but to no higher than 36° C.

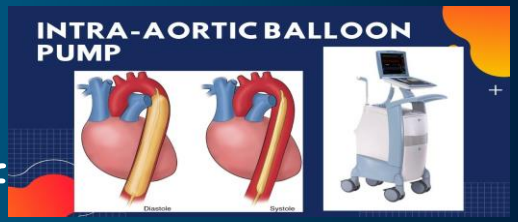
Haemodynamic monitoring and management

- Maintain perfusion with fluids, noradrenaline and/or dobutamine, depending on individual patient need for intravascular volume, vasoconstriction or inotropy.

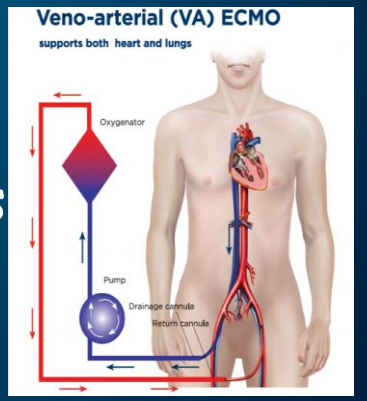
- Do not give steroids routinely after cardiac arrest.

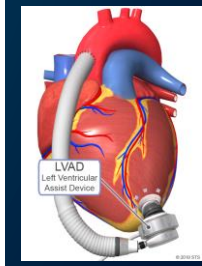
- Avoid hypokalaemia, which is associated with ventricular arrythmias

- Consider mechanical circulatory support (such as intra-aortic balloon pump, left-ventricular assist device or arterio-venous extra corporal membrane oxygenation) for persisting cardiogenic shock from left ventricular failure if treatment with fluid resuscitation, inotropes, and vasoactive drugs is insufficient.

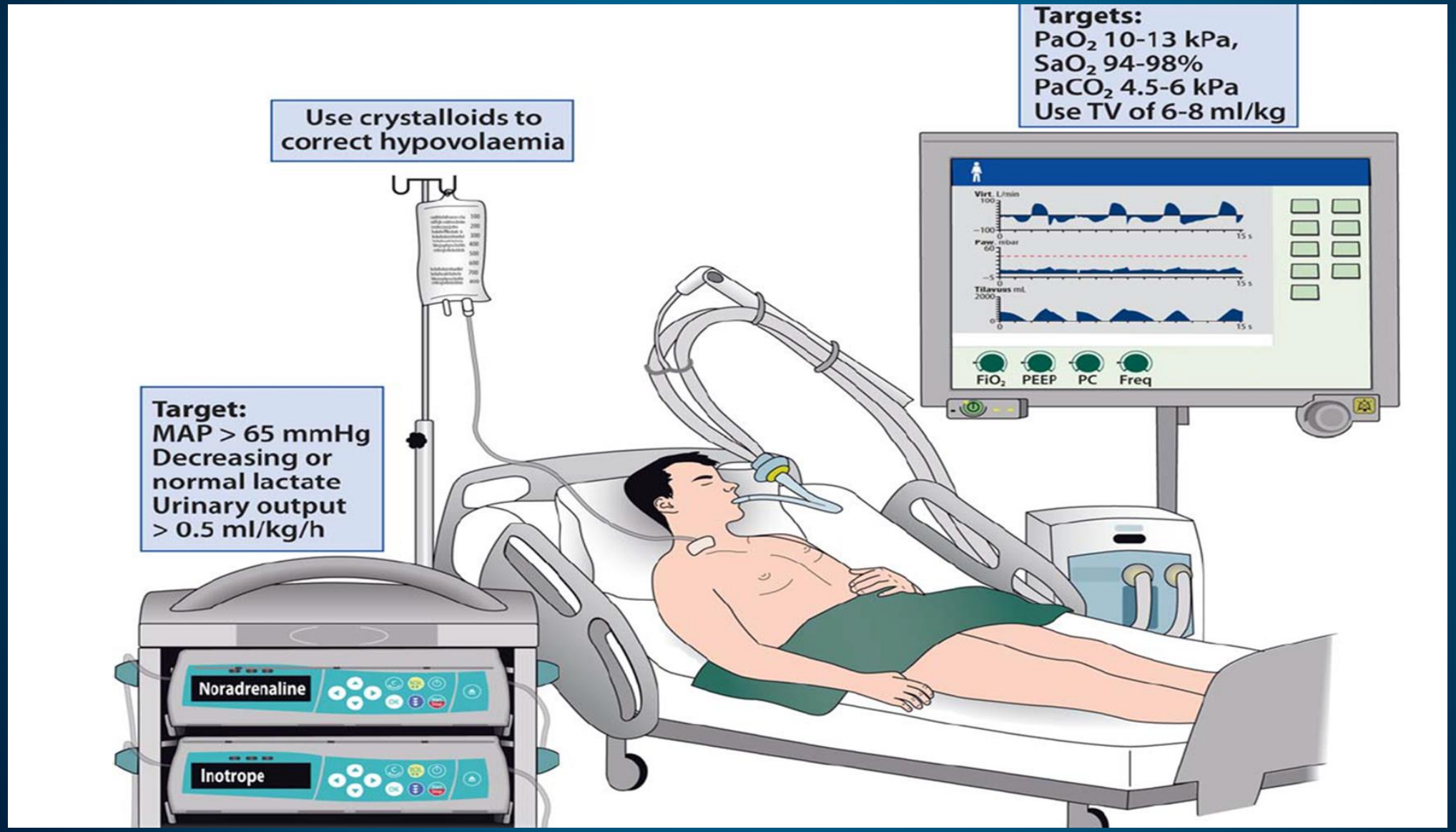


- Left-ventricular assist devices or arterio-venous extra corporal membrane oxygenation should also be considered in haemodynamically unstable patients with acute coronary syndromes (ACS) and recurrent ventricular tachycardia (VT) or ventricular fibrillation (VF) despite optimal therapy

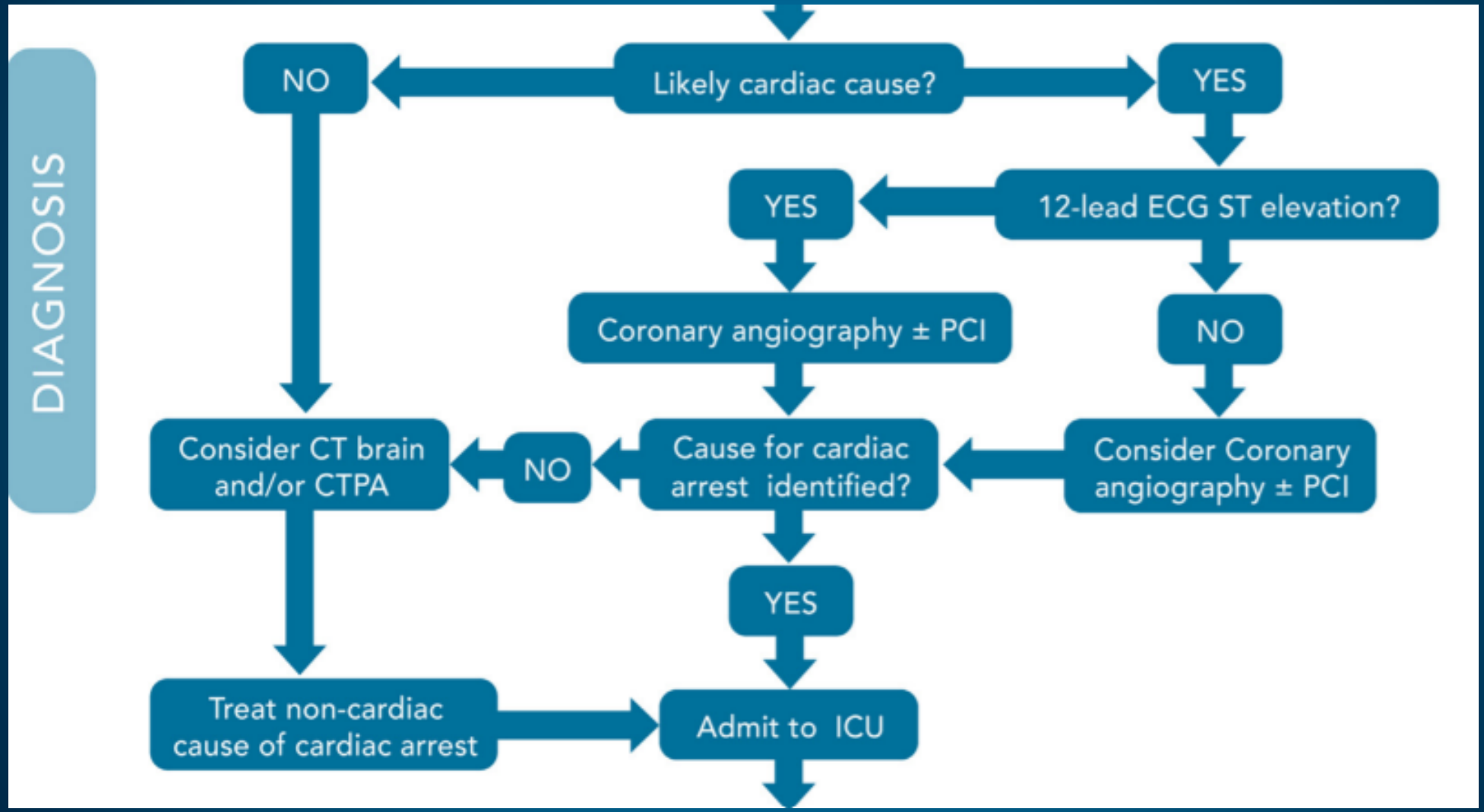




Ventilation /Haemodynamic monitoring and management



2015 Guidelines	2021 Guidelines	Rationale for change
Blood pressure target		
Target the mean arterial blood pressure to achieve an adequate urine output (1 mL kg^{-1} h^{-1}) and normal or decreasing plasma lactate values, taking into consideration the patient's normal blood pressure, the cause of the arrest and the severity of any myocardial dysfunction.	Avoid hypotension (<65 mmHg). Target MAP to achieve adequate urine output (>0.5 mL kg^{-1} h^{-1}) and normal or decreasing lactate.	Several studies show that hypotension (<65 mmHg) is consistently associated with poor outcome. Although we have stated a threshold value for blood pressure, optimal MAP targets are likely to need to be individualised.


DIAGNOSIS
Likely cardiac cause?
NO
YES
12-lead ECG ST elevation?
YES
NO
Coronary angiography ± PCI
Consider Coronary angiography ± PCI
Cause for cardiac arrest identified?
NO
Consider CT brain and/or CTPA
YES
Admit to ICU
Treat non-cardiac cause of cardiac arrest

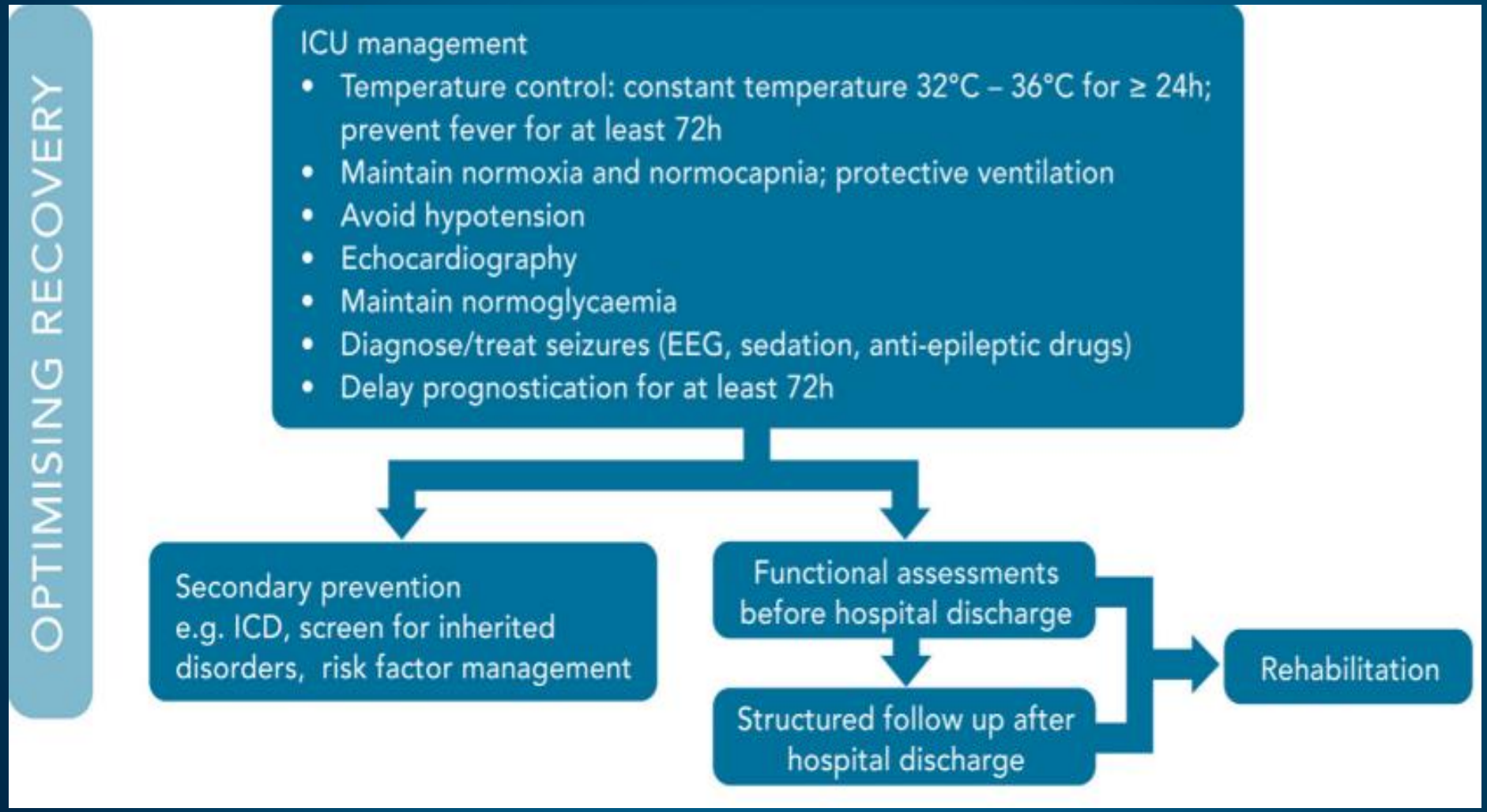
Coronary reperfusion

- Emergent cardiac catheterisation ,laboratory evaluation (and immediate PCI if required) should be performed in adult patients with ROSC after cardiac arrest of suspected cardiac origin with ST-elevation on the ECG.

- In patients with ROSC after out-of-hospital cardiac arrest (OHCA) without ST-elevation on the ECG, emergent cardiac catheterization laboratory evaluation should be considered if there is an estimated high probability of acute coronary occlusion (e.g. patients with haemodynamic and/or electrical instability).

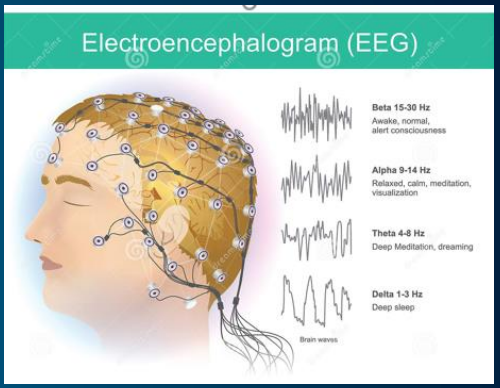
2015 Guidelines	2021 Guidelines	Rationale for change
Coronary angiography It is reasonable to discuss and consider emergent cardiac catheterisation laboratory evaluation after ROSC in patients with the highest risk of a coronary cause for their cardiac arrest	In patients with ROSC after OHCA without ST-elevation on the ECG, emergent cardiac catheterisation laboratory evaluation should be considered if there is an estimated high probability of acute coronary occlusion (e.g. patients with haemodynamic and/or electrical instability).	A randomised controlled trial showed no difference in 90-day survival following out of hospital VF cardiac arrest among patients without ST-elevation on the ECG allocated to immediate coronary angiography versus delayed angiography.[10] Recent ESC guidelines state that 'Delayed as opposed to immediate angiography should be considered in haemodynamically stable patients without ST-segment elevation successfully resuscitated after an out-of-hospital cardiac arrest'.[11]

Disability (optimising neurological recovery)



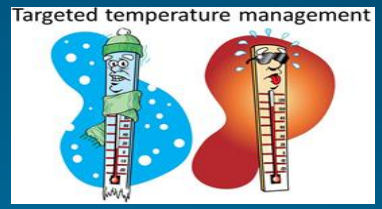
Control of seizures

- We recommend using electroencephalography (EEG) to diagnose electrographic seizures in patients with clinical convulsions and to monitor treatment effects
- To treat seizures after cardiac arrest, we suggest levetiracetam or sodium valproate as first-line antiepileptic drugs in addition to sedative drugs.
- We suggest that routine seizure prophylaxis is not used in post cardiac arrest patients



2015 Guidelines	2021 Guidelines	Rationale for change
Treatment of seizures		
Treat [seizures] with sodium valproate, levetiracetam, phenytoin, benzodiazepines, propofol, or a barbiturate.	To treat seizures after cardiac arrest, we suggest levetiracetam or sodium valproate as first-line antiepileptic drugs in addition to sedative drugs.	In a recently reported trial, valproate, levetiracetam and fosphenytoin were equally effective in terminating convulsive status epilepticus but fosphenytoin caused more episodes of hypotension.[12]

Temperature control



- We recommend targeted temperature management (TTM) for adults after either OHCA or in-hospital cardiac arrest (IHCA) (with any initial rhythm) who remain unresponsive after ROSC

- Maintain a target temperature at a constant value between 32 °C and 36 °C for at least 24 h

- Avoid fever (>37.7 °C) for at least 72 h after ROSC in patients who remain in coma

- Do not use pre-hospital intravenous cold fluids to initiate hypothermia

2015 Guidelines	2021 Guidelines	Rationale for change
Temperature control • Maintain a constant, target temperature between 32 °C and 36 °C for those patients in whom temperature control is used (strong recommendation, moderate-quality evidence). • Whether certain subpopulations of cardiac arrest patients may benefit from lower (32–34 °C) or higher (36 °C) temperatures remains unknown, and further research may help elucidate this. • TTM is recommended for adults after OHCA with an initial shockable rhythm who remain unresponsive after ROSC (strong recommendation, low-quality evidence). • TTM is suggested for adults after OHCA with an initial non-shockable rhythm who remain unresponsive after ROSC (weak recommendation, very low-quality evidence). • TTM is suggested for adults after IHCA with any initial rhythm who remain unresponsive after ROSC (weak recommendation, very low-quality evidence). • If targeted temperature management is used, it is suggested that the duration is at least 24 h (weak recommendation, very low-quality evidence).	• We recommend TTM for adults after either OHCA or IHCA (with any initial rhythm) who remain unresponsive after ROSC. • Maintain a target temperature at a constant value between 32 °C and 36 °C for at least 24 h. • Avoid fever (>37.7 °C) for at least 72 h after ROSC in patients who remain in coma.	A recent randomised controlled trial of both IHCA and OHCA patients with initial non-shockable rhythms showed a higher percentage of patients survived with a favourable neurological outcome when treated with TTM at 33 °C versus 37 °C.[13] This has enabled the recommendation to be extended to all rhythms and locations. The definition of fever (>37.7 °C) is consistent with that used in the TTM2 trial.[14]

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TEMPERATURE CONTROL

KEY EVIDENCE

A randomised trial and a quasi-randomised trial demonstrated improved neurological outcome at hospital discharge or at 6 months in comatose patients after out-of-hospital witnessed cardiac arrest with an initial shockable rhythm who were cooled to 32–34°C for 12 to 24 hours

One randomised controlled trial in comatose post-non-shockable rhythm cardiac arrest patients showed the use of targeted temperature (TTM) at 33°C compared with 37°C led to a higher percentage of patients who survived with a favourable neurological outcome at day 90

KEY RECOMMENDATIONS

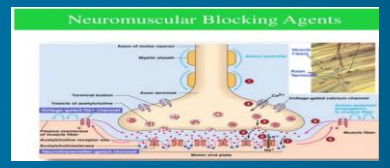
Use TTM for adults after cardiac arrest (with any initial rhythm) who remain unresponsive after ROSC

Maintain a constant target temperature between 32°C and 36°C for at least 24h

General intensive care management

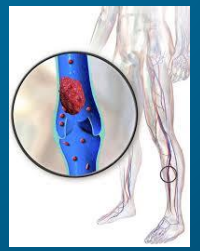
- Use short acting sedatives and opioids.

- Avoid using a neuromuscular blocking drug routinely in patients undergoing TTM, but it may be considered in case of severe shivering during TTM

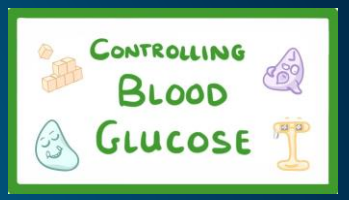


- Provide stress ulcer prophylaxis routinely in cardiac arrest patients.

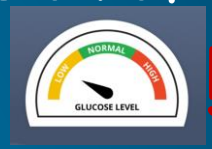
- Provide deep venous thrombosis prophylaxis



General intensive care management



- Target a blood glucose of 140-180mg/dl using an infusion of insulin if required. Avoid hypoglycaemia (<70mg/dL)



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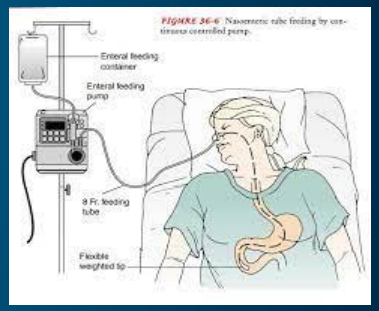
- Start enteral feeding at low rates (trophic feeding) during TTM and increase after rewarming if indicated. If TTM of 36 C is used as the target temperature, gastric feeding rates may be increased early during TTM



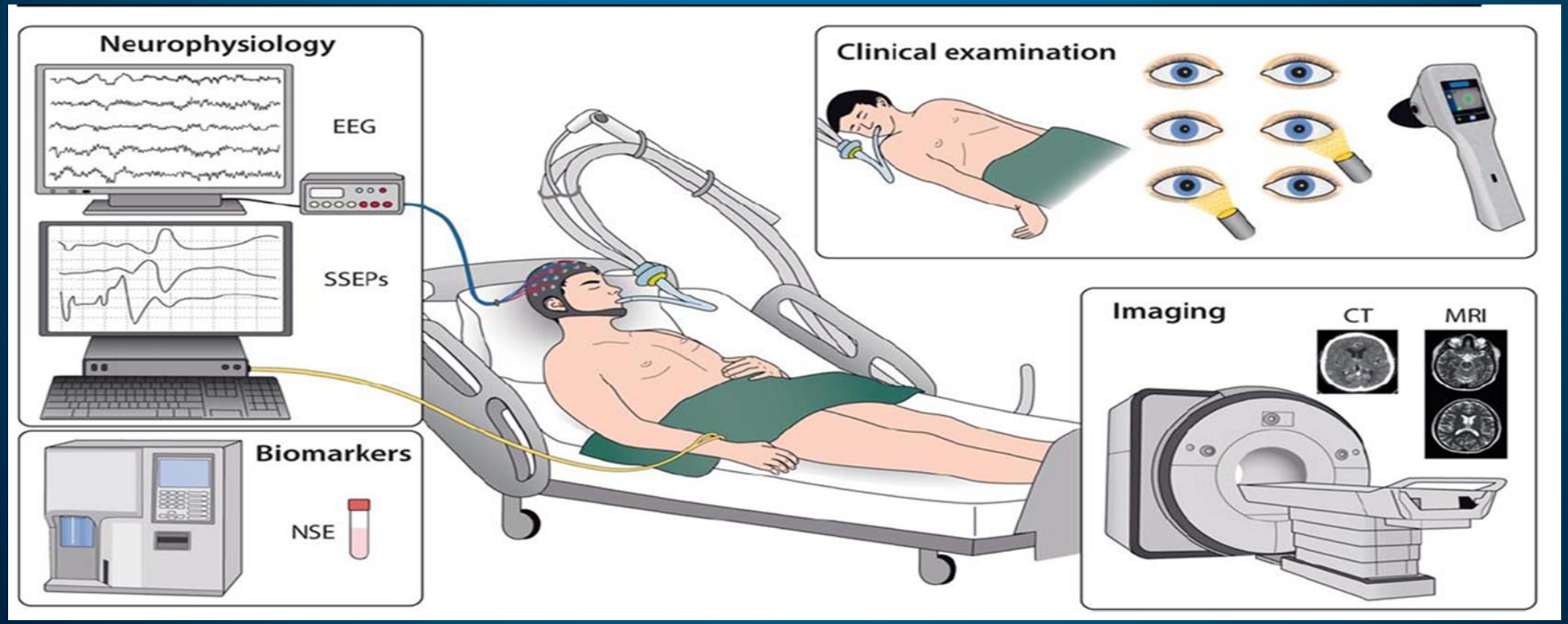
- We do not recommend using prophylactic antibiotics routinely

?

2015 Guidelines	2021 Guidelines	Rationale for change
General intensive care management Short-acting drugs (e.g., propofol, alfentanil, remifentanil) will enable more reliable and earlier neurological assessment and prognostication Following ROSC maintain the blood glucose at $\leq$10 mmol L^{-1} (180 mg dL^{-1}) and avoid hypoglycaemia.	• Use short acting sedatives and opioids. • Avoid using a neuromuscular blocking drug routinely in patients undergoing TTM, but it may be considered in case of severe shivering during TTM. • Provide stress ulcer prophylaxis routinely in cardiac arrest patients. • Provide deep venous thrombosis prophylaxis. • Target a blood glucose of 7.8–10 mmol L^{-1} (140–180 mg dL^{-1}) using an infusion of insulin if required; avoid hypoglycaemia ($<$4.0 mmol L^{-1} ($<$70 mg dL^{-1}). • Start enteral feeding at low rates (trophic feeding) during TTM and increase after re-warming if indicated. If TTM of 36 °C is used as the target temperature, trophic gastric feeding rates may be increased early during TTM. • We do not recommend using prophylactic antibiotics routinely.	The 2015 guidelines included very few state-ments on general intensive care management. For 2020 we have several best practice state-ments based mainly on data extrapolated from other critically ill patient groups.

Prognostication

In patients who are comatose after resuscitation from cardiac arrest, neurological prognostication should be performed using clinical examination, electrophysiology, biomarkers, and imaging, to both inform patient's relatives and to help clinicians to target treatments based on the patient's chances of achieving a neurologically meaningful recovery



Prognostication

- No single predictor is 100% accurate. Therefore, a multimodal neuroprognostication strategy is recommended
- When predicting poor neurological outcome, a high specificity and precision are desirable, to avoid falsely pessimistic predictions
- The clinical neurological examination is central to prognostication
- To avoid falsely pessimistic predictions, clinicians should avoid potential confounding from sedatives and other drugs that may confound the results of the tests
- When patients are treated with TTM, daily clinical examination is advocated but final prognostic assessment should be undertaken only after rewarming
- Clinicians must be aware of the risk of a self-fulfilling prophecy bias, occurring when the results of an index test predicting poor outcome is used for treatment decisions, especially regarding life sustaining therapies
- Index tests for neurological prognostication are aimed at assessing the severity of hypoxic-ischaemic brain injury. The neurological prognosis is one of several aspects to consider in discussions around an individual's potential for recovery

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PROGNOSTICATION

KEY EVIDENCE

A systematic review of predictors of poor neurological outcome identified 94 studies including 30,200 comatose post-cardiac arrest patients

KEY RECOMMENDATIONS

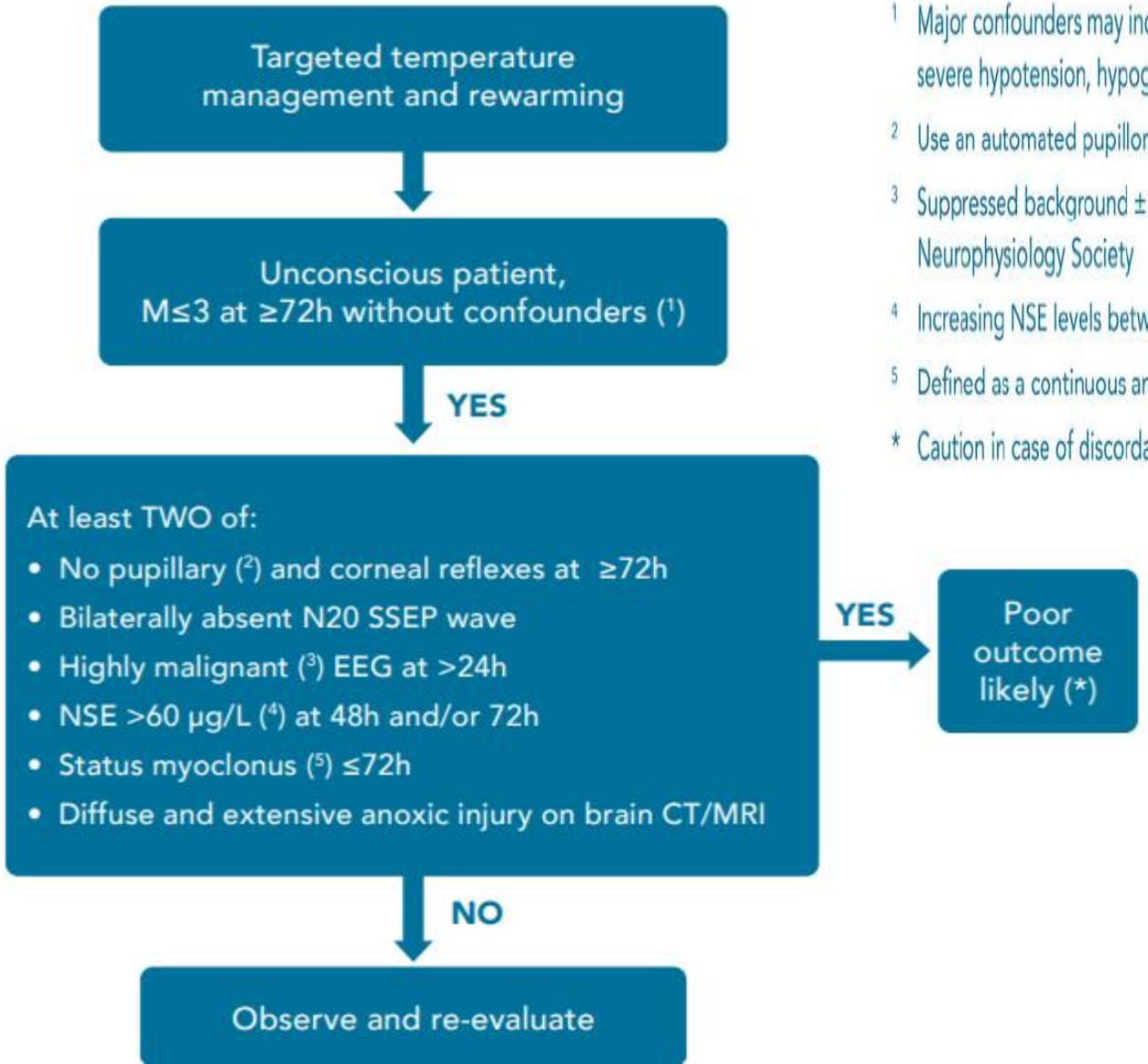
A Glasgow Motor Score of ≤ 3 at ≥ 72h or later after ROSC may identify patients in whom neurological prognostication is needed

No single predictor is 100% accurate; therefore, use a multimodal neuroprognostication strategy comprising clinical examination, electrophysiology, biomarkers, and imaging

Beware of confounding caused by residual sedation

NEUROPROGNOSTICATION FOR THE COMATOSE PATIENT AFTER RESUSCITATION FROM CARDIAC ARREST

EUROPEAN RESUSCITATION COUNCIL GUIDELINES 2021



1 Major confounders may include analgo-sedation, neuromuscular blockade, hypothermia, severe hypotension, hypoglycaemia, sepsis, and metabolic and respiratory derangements

2 Use an automated pupillometer, when available, to assess pupillary light reflex

3 Suppressed background ± periodic discharges or burst-suppression, according to American Clinical Neurophysiology Society

4 Increasing NSE levels between 24h-48h or 24/48 and 72h further support a likely poor outcome

5 Defined as a continuous and generalised myoclonus persisting for 30 minutes or more

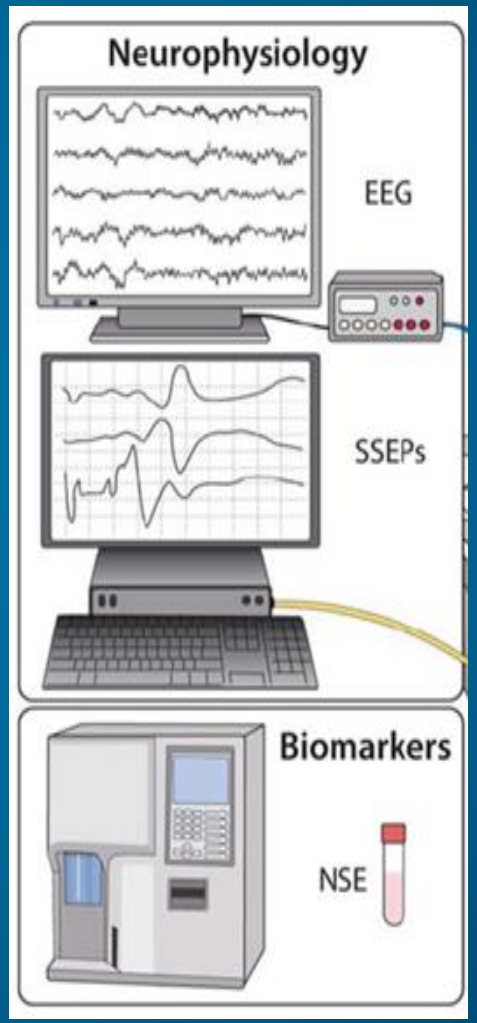
* Caution in case of discordant signs indicating a potentially good outcome (see text for details).

Most of these signs can be recorded before 72 h from ROSC, however their results will be evaluated only at the time of clinical prognostic assessment.

We also suggest recording the EEG in the presence of myoclonic jerks to enable detection of any associated epileptiform activity or EEG signs, such as background reactivity or continuity, suggesting a potential for neurological recovery.

Neurophysiology

- Perform an EEG in patients who are unconscious after the arrest.
- Highly malignant EEG-patterns include suppressed background with or without periodic discharges and burst-suppression. We suggest using these EEG-patterns after the end of TTM and after sedation has been cleared as indicators of a poor prognosis.
- The presence of unequivocal seizures on EEG during the first 72 h after ROSC is an indicator of a poor prognosis.
- Absence of background reactivity on EEG is an indicator of poor prognosis after cardiac arrest.
- Bilateral absence of somatosensory evoked cortical N20- potentials is an indicator of poor prognosis after cardiac arrest.
- Always consider the results of EEG and somatosensory evoked potentials (SSEP) in the context of clinical examination findings and other tests. Always consider using a neuromuscular blocking drug when performing SSEP.

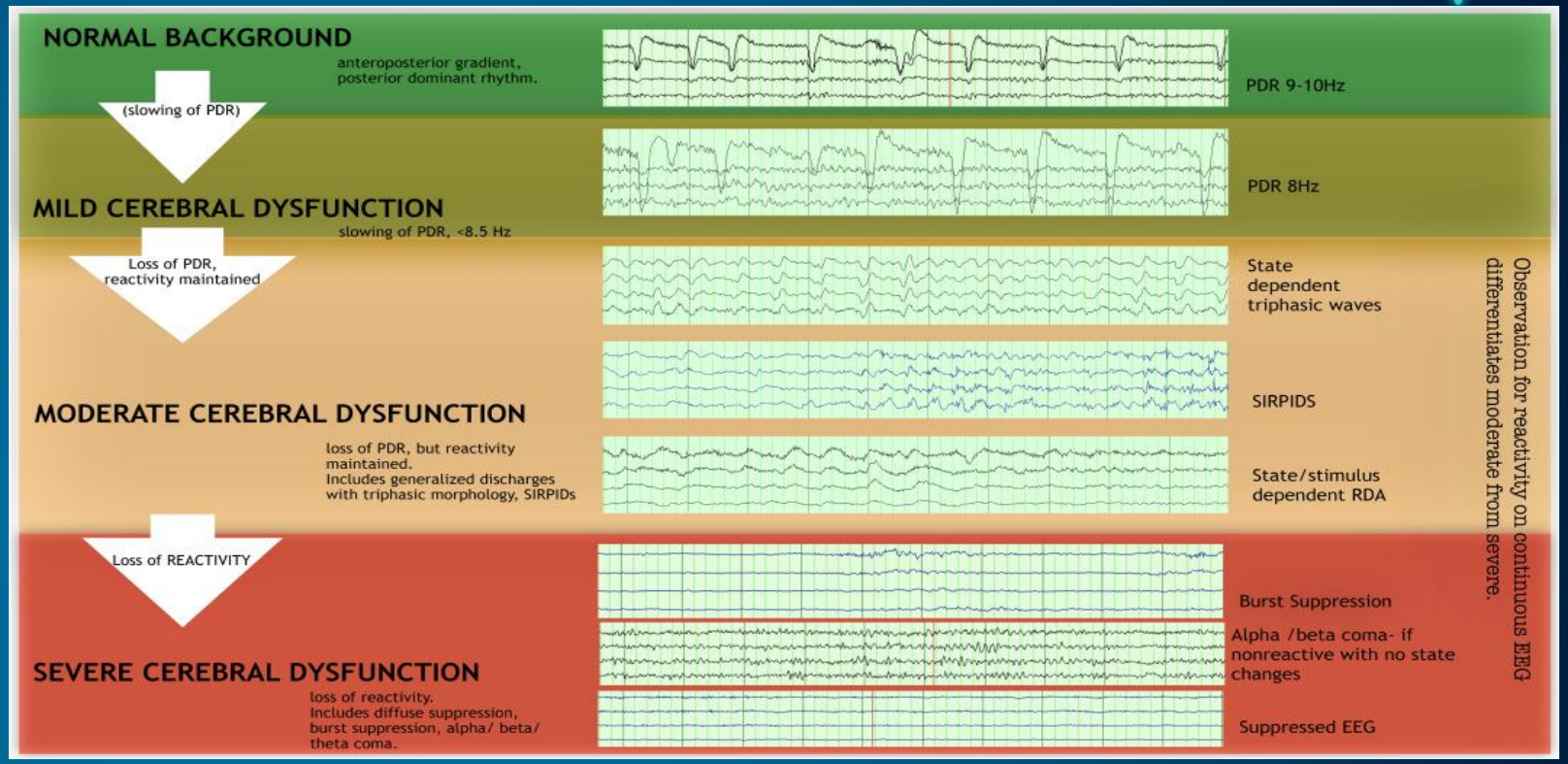


Biomarkers

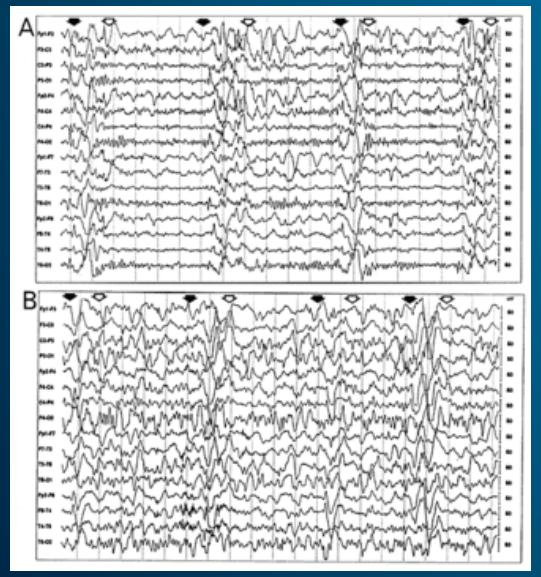
Use serial measurements of NSE **(Neuron-specific enolase)** in combination with other methods to predict outcome after cardiac arrest

Increasing values between 24 and 48 h or 72 h in combination with high values at 48 and 72 h indicate a poor prognosis.

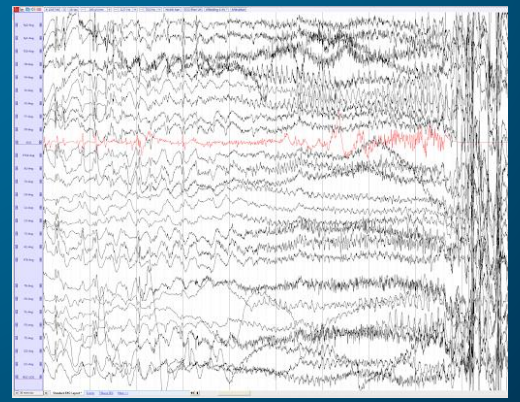
Neurophysiology



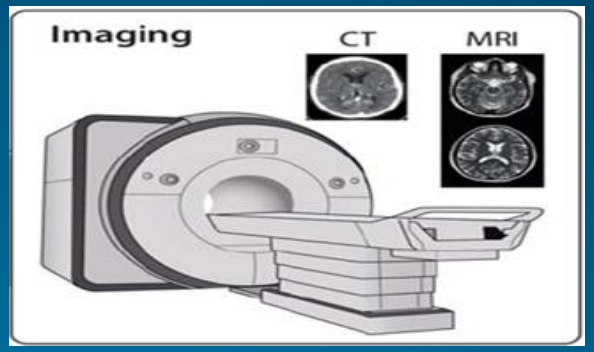
Burst-suppression



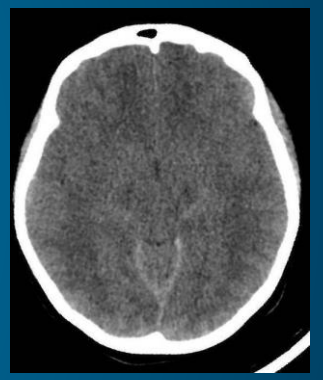
Status epilepticus



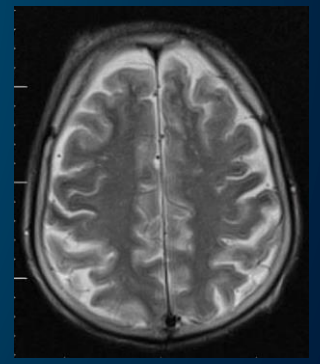
Imaging



- Use brain imaging studies for predicting poor neurological outcome after cardiac arrest in combination with other predictors, in centres where specific experience in these studies is available



- Use presence of generalised brain oedema, manifested by a marked reduction of the grey matter/white matter ratio on brain CT, or extensive diffusion restriction on brain MRI to predict poor neurological outcome after cardiac arrest



- Always consider findings from imaging in combination with other methods for neurological prognostication

RECOMMENDATIONS FOR IN-HOSPITAL FUNCTIONAL ASSESSMENTS, FOLLOW-UP AND REHABILITATION AFTER CARDIAC ARREST

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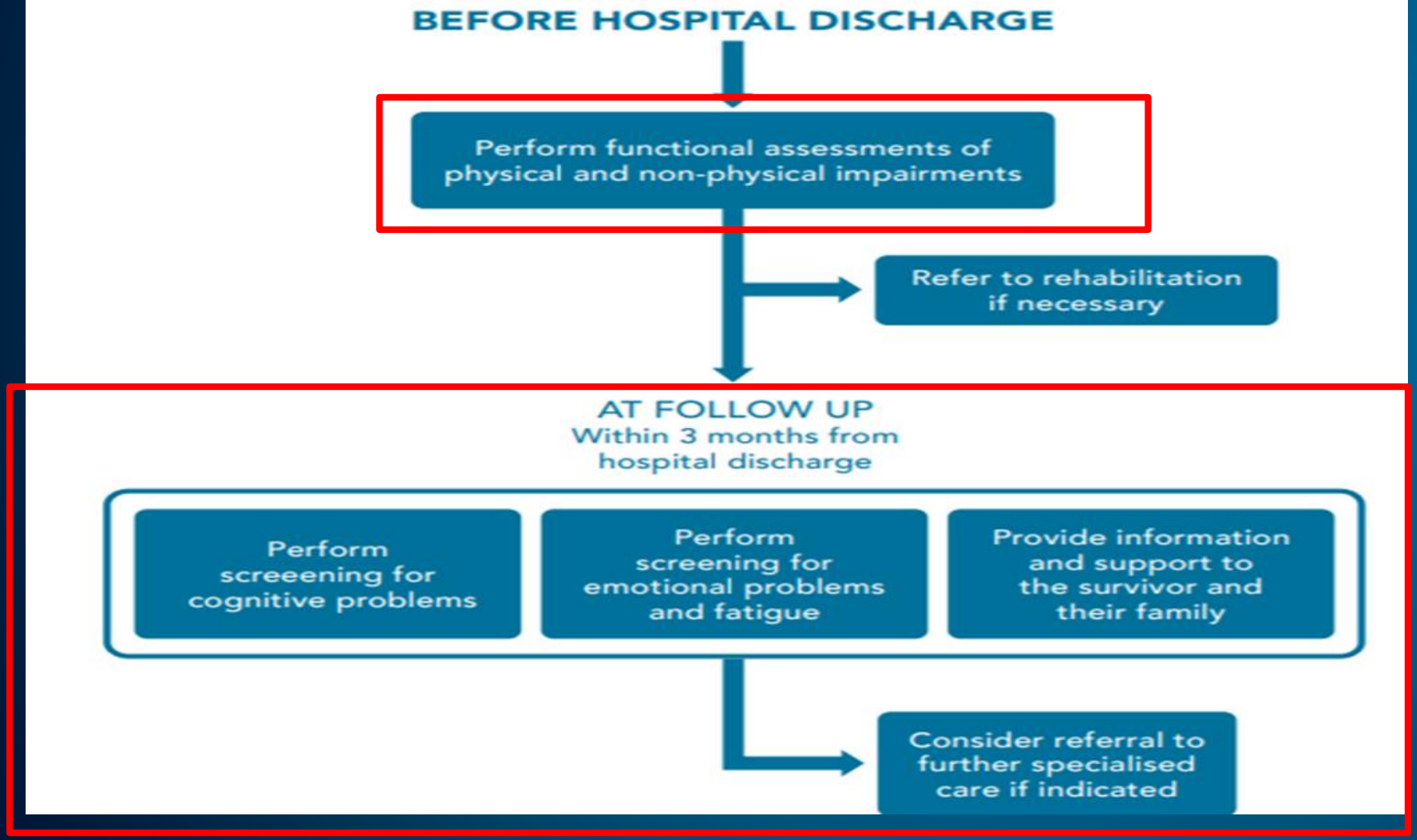


Long-term outcome after cardiac arrest

- Perform functional assessments of physical and non-physical impairments before discharge from the hospital to identify early rehabilitation needs and refer to rehabilitation if necessary

- Organise follow-up for all cardiac arrest survivors within 3 months after hospital discharge, including:

1. Screening for cognitive problems
2. Screening for emotional problems and fatigue
3. Providing information and support for survivors and family members

POST RESUSCITATION CARE 2021

LONG-TERM OUTCOME AFTER CARDIAC ARREST

EUROPEAN RESUSCITATION COUNCIL

KEY EVIDENCE

Neurological sequelae may affect long term outcome, with cognitive impairment seen in 40-50% of cardiac arrest survivors

A scientific statement focusing on survivorship highlights that discharge planning and organisation of further rehabilitation needs after cardiac arrest is often lacking

Survivors also report long-lasting emotional, physical and fatigue related problems to affect their everyday life

KEY RECOMMENDATIONS

Perform functional assessments of physical and non-physical impairments before discharge from the hospital to identify early rehabilitation needs and refer to rehabilitation if necessary

Organise follow-up for all cardiac arrest survivors within 3 months after hospital discharge, including screening for cognitive problems, screening for emotional problems and fatigue, and providing information and support for survivors and family members

2015 Guidelines	2021 Guidelines	Rationale for change
Rehabilitation Follow-up care should be organised systematically and can be provided by a physician or specialised nurse. It includes at least the following aspects: • Screening for cognitive impairments • Screening for emotional problems • Provision of information	• Perform functional assessments of physical and non-physical impairments before discharge from the hospital to identify early rehabilitation needs and refer to rehabilitation if necessary. • Organise follow-up for all cardiac arrest survivors within 3 months after hospital discharge, including: 1. Screening for cognitive problems. 2. Screening for emotional problems and fatigue. 3. Providing information and support for survivors and family members.	The authorship of the 2021 guidelines now includes 3 individuals with expertise on long-term outcomes and rehabilitation after cardiac arrest compared with one author in 2015. The 2021 guidelines include greater emphasis on functional assessments of physical and non-physical impairments before discharge and long-term follow up and rehabilitation. There is greater recognition of the importance of survivorship after cardiac arrest. The recommendations in this section are all best practice statements

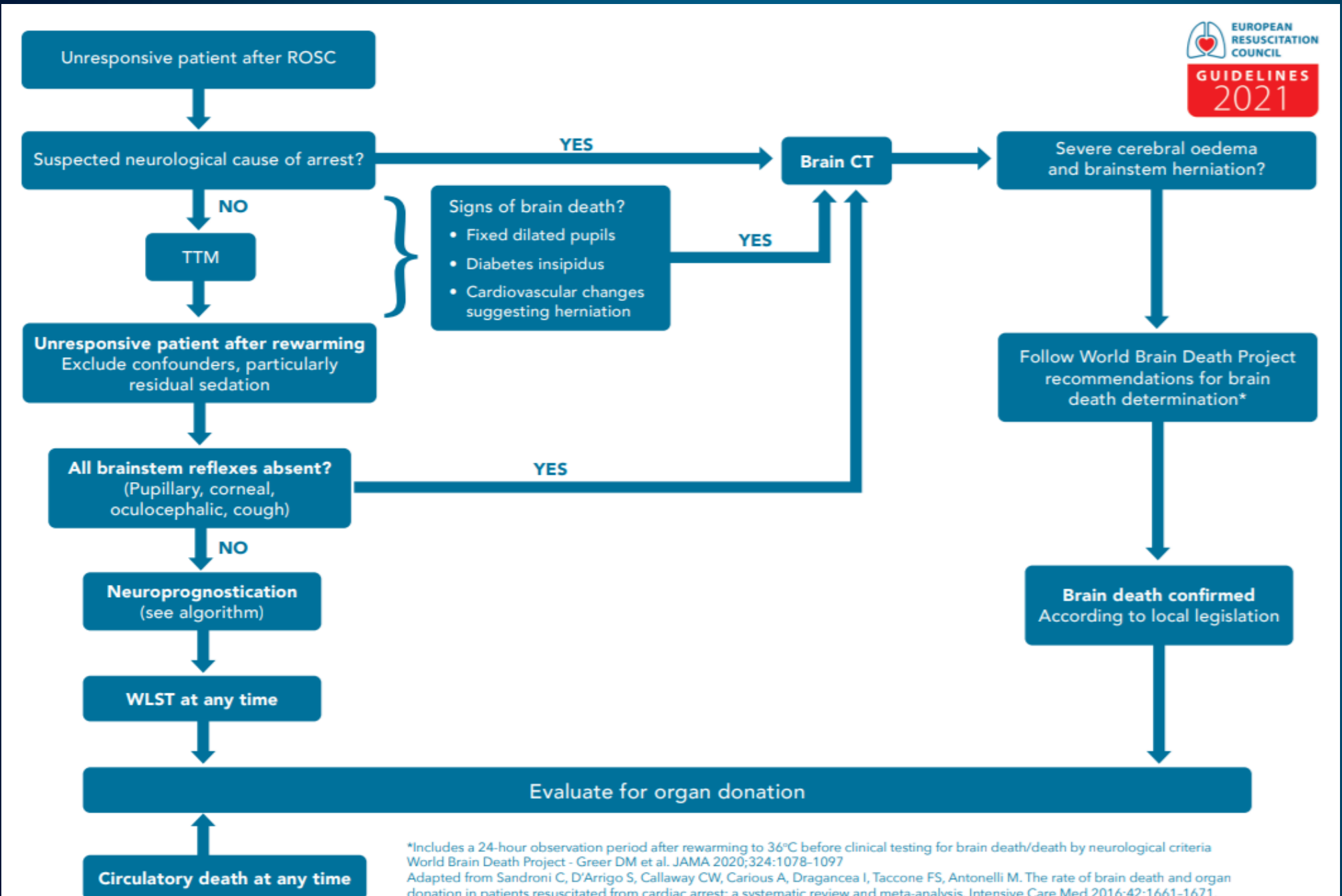
Withdrawal of life-sustaining therapy

- Separate discussions around withdrawal of life-sustaining therapy (WLST) and the assessment of prognosis for neurological recovery

- WLST decisions should consider aspects other than brain injury such as age, co-morbidity, general organ function and the patients' preferences

- Allocate sufficient time for communication around the level-of treatment decision within the team and with the relatives

Organ donation after cardiac arrest algorithm.



POST RESUSCITATION CARE 2021

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ORGAN DONATION

KEY EVIDENCE

Post cardiac arrest patients are an increasing source of solid organ donors

Observational studies show that organs (heart, lung, kidney, liver, pancreas, intestine) from donors who have had CPR have similar graft survival rates compared with donors who have not had CPR

KEY RECOMMENDATIONS

Consider organ donation in post-cardiac arrest patients who have achieved ROSC and who fulfil neurological criteria for death

In comatose ventilated patients who do not fulfil neurological criteria for death, when a decision to start end-of-life care and withdrawal of life support is made, organ donation should be considered after circulatory arrest occurs

ΕΥΧΑΡΙΣΤΩ ΠΟΛΥ!!!