

# 2025 Korean Guidelines for Cardiopulmonary Resuscitation: Part 6. Post-cardiac arrest care

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This guideline summarizes evidence-based post-cardiac arrest care following the return of spontaneous circulation (ROSC) in adults, incorporating updates from the 2025 Korean Guidelines for Cardiopulmonary Resuscitation and contemporary international evidence. Recommendations were informed by recent randomized controlled trials and systematic reviews, with an emphasis on patient-centered outcomes and practical clinical applications. After ROSC, early evaluation should focus on identifying reversible causes. A 12-lead electrocardiogram should be obtained promptly, with echocardiography and whole-body computed tomography performed when clinically indicated to assess cardiac function and detect noncardiac or occult etiologies. Respiratory management aims to minimize secondary brain injury by preventing hypoxemia and hyperoxemia. High inspired oxygen concentrations may be used initially, followed by titration to an appropriate oxygen saturation level once reliable measurements are available, and ventilation should target normocapnia. Hemodynamic management prioritizes adequate organ perfusion and prompt treatment of shock, including active correction of hypotension. Routine immediate coronary angiography is not recommended in patients without ST-segment elevation. However, urgent angiography is indicated in those with ST-segment elevation, cardiogenic shock, or a high likelihood of ongoing myocardial ischemia. In comatose survivors, temperature control is essential. The selected target temperature should be maintained for at least 24 hours, with active fever prevention for 36 to 72 hours. Additional intensive care unit management includes glucose control and seizure monitoring. Routine prophylactic antibiotics or anticonvulsants are not recommended. Neuroprognostication should use a multimodal approach after confounders, such as sedation and temperature management, are addressed, integrating clinical examination, electrophysiology, biomarkers, and neuroimaging to support individualized decision-making.

**Keywords** Cardiopulmonary resuscitation; Heart arrest; Post cardiac arrest syndrome

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## INTRODUCTION

The 2025 Korean Guidelines for Cardiopulmonary Resuscitation provide evidence-based medical recommendations for advanced resuscitation. These guidelines were based on the 2025 International Liaison Committee on Resuscitation (ILCOR) Consensus on Science and Treatment Recommendations [1]. The key recommendations are summarized below.

## KEY RECOMMENDATIONS

### Post-cardiac arrest care

#### *Diagnostic tests for cardiac arrest survivors*

- It is strongly recommended that a 12-lead electrocardiogram (ECG) be performed in adult patients who achieve return of spontaneous circulation (ROSC) after cardiac arrest (strong recommendation, moderate certainty of evidence).
- Whole-body computed tomography (CT) may be considered in adult patients who achieve ROSC after cardiac arrest (weak recommendation, low certainty of evidence).
- Echocardiography may be considered in adult patients who achieve ROSC after cardiac arrest (weak recommendation, low certainty of evidence).

#### *Airway management and ventilation*

##### 1) Oxygen targets

- Avoiding hypoxemia is strongly recommended for adult patients after ROSC after cardiac arrest (strong recommendation, moderate certainty of evidence).
- Administration of 100% oxygen is strongly recommended until accurate measurements of oxygen saturation or arterial partial pressure of oxygen are available in adult patients after ROSC (prehospital phase: strong recommendation, moderate certainty of evidence; in-hospital phase: strong recommendation, low certainty of evidence).
- To avoid hyperoxemia, titration of the fraction of inspired oxygen to maintain an arterial oxygen saturation of 94% to 98% may be considered in adult patients after ROSC (weak recommendation, low certainty of evidence).

##### 2) Carbon dioxide targets

- Maintenance of PaCO<sub>2</sub> within the normal range of 35 to 45 mmHg is recommended in adult patients after ROSC (strong recommendation, moderate certainty of evidence).

#### *Hemodynamic management*

- In out-of-hospital cardiac arrest (OHCA) survivors, maintenance of a mean arterial pressure of at least 60 to 65 mmHg is recommended (strong recommendation, moderate certainty of evidence).
- In in-hospital cardiac arrest survivors, maintenance of a mean arterial pressure of at least 60 to 65 mmHg is recommended (strong recommendation, moderate certainty of evidence).

#### *Coronary angiography*

- Routine early coronary angiography is not recommended in comatose adult patients without ST-segment elevation who achieve ROSC after cardiac arrest. A delayed approach after stabilization or neurological recovery may be considered (weak recommendation, low certainty of evidence).
- Emergency coronary angiography is recommended for comatose adult patients who achieve ROSC after cardiac arrest and have ST-segment elevation or evidence of cardiogenic shock (strong recommendation, low certainty of evidence).

#### *Targeted temperature management*

##### 1) Indications

- Targeted temperature management (TTM) is recommended for comatose patients who achieve ROSC after cardiac arrest (strong recommendation, moderate certainty of evidence).

##### 2) Target temperature and duration

- A target temperature between 33 and 37.5 °C is recommended in comatose patients after ROSC (strong recommendation, moderate certainty of evidence).
- Maintenance of the selected target temperature for at least 24 hours should be considered (weak recommendation, moderate certainty of evidence).
- TTM with a target of 33 °C may be considered in patients with OHCA exhibiting an initial nonshockable rhythm (weak recommendation, low certainty of evidence).

##### 3) Management of hypothermic patients

- Active rewarming to normothermia has not been suggested in comatose patients who are hypothermic after achieving ROSC (good practice statement).

##### 4) Prehospital cooling

- The routine use of prehospital cooling by rapid intravenous infusion of large volumes of cold fluids after ROSC is not recommended (strong recommendation, moderate certainty of evidence).

## 5) Methods of temperature control and monitoring

- The use of either surface or intravascular temperature control methods may be considered in comatose patients after ROSC (weak recommendation, low certainty of evidence).
- When cooling devices are used, temperature control systems that incorporate continuous temperature monitoring and feedback mechanisms are recommended to maintain the target temperature (good practice statement).

## 6) Fever prevention

- Active prevention of fever for 36 to 72 hours after ROSC is recommended for patients who remain comatose (expert consensus recommendation).

*Glucose control*

- A target blood glucose range of 144 to 180 mg/dL may be considered for patients who achieve ROSC (weak recommendation, moderate certainty of evidence).
- Immediate correction with intravenous glucose is recommended when hypoglycemia occurs (strong recommendation, moderate certainty of evidence).

*Seizure management*

- The prophylactic use of antiepileptic drugs is not recommended in adult patients resuscitated after cardiac arrest (weak recommendation, very low certainty of evidence).
- Treatment is recommended for adult patients resuscitated from cardiac arrest when clinically evident or electrographic seizures are identified (expert consensus recommendation).
- Treatment may be considered in comatose adult patients when rhythmic or periodic electroencephalography (EEG) patterns consistent with the ictal-interictal continuum are observed (weak recommendation and low certainty of evidence).

*Prophylactic antibiotics*

- The routine use of prophylactic antibiotics is not recommended for comatose patients after cardiac arrest (weak recommendation, moderate certainty of evidence).

*Steroids*

- Routine administration of steroids is not recommended for comatose patients after cardiac arrest (weak recommendation, low certainty of evidence).

**Prediction of poor neurological outcome after cardiac arrest***Neurological examination*

- Bilateral absence of the pupillary light reflex at  $\geq 72$  hours after ROSC may be considered to predict poor neurological outcome in comatose patients (weak recommendation, very low certainty of evidence).
- Bilateral absence of the corneal reflex at  $\geq 72$  hours after ROSC may be considered to predict poor neurological outcome in comatose patients (weak recommendation, very low certainty of evidence).
- Quantitative pupillometry at  $\geq 72$  hours after ROSC may be considered to predict poor neurological outcome (weak recommendation, low certainty of evidence).
- EEG is recommended to identify the associated epileptiform activity when myoclonus is observed (weak recommendation, very low certainty of evidence).

*Electrophysiological studies*

- Bilateral absence of the N20 response on somatosensory evoked potentials at  $\geq 24$  hours after ROSC, in combination with other predictors, may be considered to predict poor neurological outcome (weak recommendation, very low certainty of evidence).
- Loss of EEG reactivity should not be used alone to predict poor neurological outcomes in comatose patients after cardiac arrest (weak recommendation, very low certainty of evidence).
- Suppressed EEG patterns or suppression with periodic discharges may predict poor neurological outcomes in comatose patients (weak recommendation, very low certainty of evidence).
- Burst suppression may be considered a predictor of poor neurological outcomes in comatose adult patients after the discontinuation of sedatives (weak recommendation, very low certainty of evidence).
- Highly malignant EEG patterns may predict poor neurological outcomes in comatose adult patients after discontinuation of sedatives (weak recommendation, very low certainty of evidence).
- The absence of normal amplitude-integrated EEG patterns within 36 hours may be considered a predictor of poor neurological outcomes (weak recommendation, very low certainty of evidence).

*Biomarkers*

- Neuron-specific enolase (NSE) levels within 72 hours after ROSC, in combination with other tests, may be considered to predict neurological outcomes in comatose adult patients (weak recommendation, very low certainty of evidence).
- The use of S100B protein has not been suggested for the prediction of neurological outcomes (weak recommendation, low certainty of evidence).
- The use of serum glial fibrillary acidic protein (GFAP), serum tau protein, or neurofilament protein has not been suggested for predicting poor neurological outcomes (weak recommendation, very low certainty of evidence).

*Neuroimaging*

- The gray to white matter ratio (GWR) on brain CT may be considered a predictor of poor neurological outcomes in comatose adult patients after cardiac arrest (weak recommendation, very low certainty of evidence).
- Diffusion-weighted imaging (DWI) on brain magnetic resonance imaging (MRI) may predict poor neurological outcomes (weak recommendation, very low certainty of evidence).
- Apparent diffusion coefficient values on brain MRI may predict poor neurological outcomes (weak recommendation, very low certainty of evidence).

**Prediction of a good neurological outcome after cardiac arrest***Clinical findings*

- A motor score  $\geq 4$  on the Glasgow Coma Scale (GCS) within 4 days after ROSC may be associated with a good neurological outcome (weak recommendation, low certainty of evidence).

*Biomarkers*

- A normal serum NSE concentration ( $< 17 \mu\text{g/L}$ ) within 72 hours after ROSC may help predict a good neurological outcome (weak recommendation, low certainty of evidence).

*Neuroimaging*

- The absence of diffusion restriction on brain MRI performed between 2 and 7 days after ROSC may be associated with good neurological outcomes (weak recommendation, low certainty of evidence).

*Electrophysiological studies*

- An EEG showing a continuous or nearly continuous normal-voltage background without periodic discharges or seizures within 72 hours after ROSC may suggest good neurological outcomes (weak recommendation, low certainty of evidence).

**POST-CARDIAC ARREST CARE****Diagnostic tests for cardiac arrest survivors**

In general, the cause of OHCA is predominantly cardiac in origin, with ischemic heart disease being the most common etiology. Therefore, a 12-lead electrocardiogram (ECG) is strongly recommended for all adult patients presenting with OHCA who achieve a ROSC (Fig. 1).

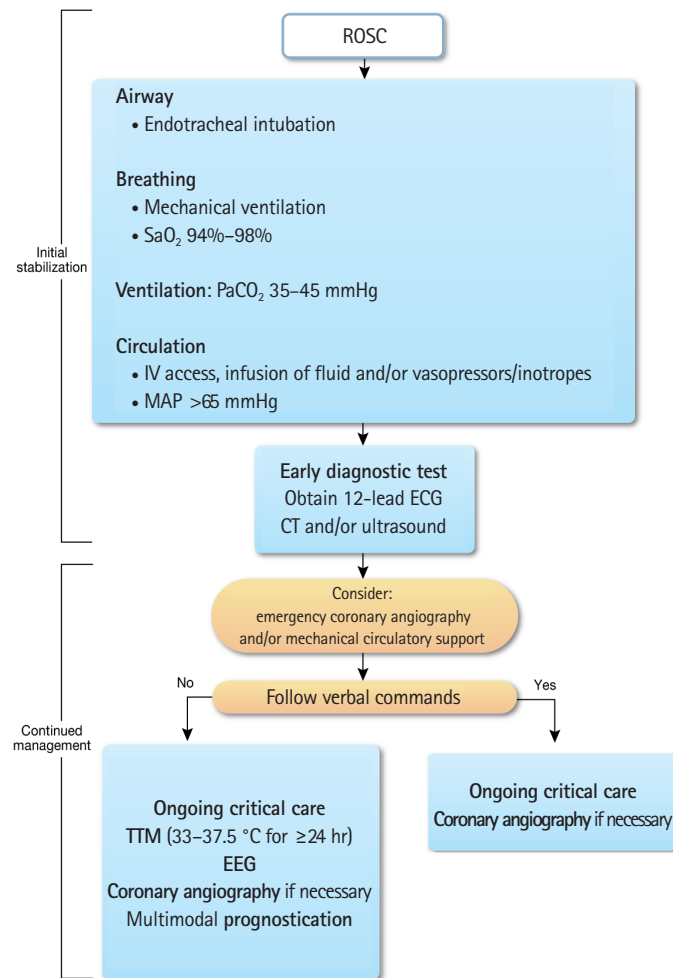
However, noncardiac causes account for approximately one-third of cardiac arrest cases, and conditions requiring specific interventions may be identified through echocardiography or CT. Whole-body CT can be used to diagnose the causes of cardiac arrest, including intracranial hemorrhage, pulmonary embolism, cardiac tamponade, aortic dissection, and pneumothorax, as well as to detect complications related to chest compressions. The reported diagnostic yield of whole-body CT ranges from 8% to 54% [2,3]. Despite the risks of contrast-associated kidney injury and limited feasibility in hemodynamically unstable patients, whole-body CT is suggested in adult patients who achieve ROSC after cardiac arrest.

Echocardiography can identify pericardial effusion, cardiac tamponade, right ventricular dilation, aortic dissection, regional wall motion abnormalities, cardiomyopathy, and hypovolemia, thereby facilitating the diagnosis and management of OHCA survivors [4–13]. Accordingly, echocardiography is suggested in adult patients who achieve ROSC.

**Airway management and ventilation**

In patients who remain comatose after ROSC, endotracheal intubation should be performed promptly if it was not established during cardiopulmonary resuscitation. Endotracheal intubation in comatose patients after ROSC enables controlled oxygen delivery and ventilation, protects the lungs from aspiration of gastric contents, and facilitates treatment aimed at minimizing secondary brain injury, including seizure control and temperature management.

Avoidance of hypoxemia is strongly recommended in adult patients who achieve ROSC after cardiac arrest, and the administration of 100% oxygen is strongly recommended until accurate



**Fig. 1.** Algorithm for post-cardiac arrest care. ROSC, return of spontaneous circulation; SaO<sub>2</sub>, arterial oxygen saturation; IV, intravenous; MAP, mean arterial pressure; ECG, electrocardiography; CT, computed tomography; TTM, targeted temperature management; EEG, electroencephalography.

measurement of oxygen saturation or arterial partial pressure of oxygen becomes available. To avoid hyperoxemia, titration of the fraction of inspired oxygen to maintain an arterial oxygen saturation of 94% to 98% is suggested in adult patients after ROSC.

Four randomized controlled trials comparing lower and higher oxygenation targets in a prehospital setting were included in a meta-analysis. The oxygenation targets in these studies included fraction of inspired oxygen (FiO<sub>2</sub>) 30% vs. 100% [14], oxygen flow rates of 2 to 4 L/min vs. ≥ 10 L/min [15], oxygen saturation targets of 94% to 98% vs. FiO<sub>2</sub> 100% [16], and oxygen saturation targets of 90%–94% vs. 98%–100% [17]. In a study of 389 patients assessing neurologically favorable survival at 12 months after cardiac arrest, lower oxygenation targets showed no benefit compared with higher oxygenation targets, and no difference was observed in 12-month survival according to the oxygenation strategy [17]. Similarly, four studies involving 549 patients

demonstrated no significant advantage of lower oxygenation targets over higher oxygenation targets with respect to survival at hospital discharge [14–17].

Five randomized controlled trials conducted in intensive care unit (ICU) settings that compared lower and higher oxygenation targets were also included in a meta-analysis [4,18–21]. Additional studies reporting 1-year outcomes from previous trials were included [22,23]. Analysis of neurologically favorable survival at 1 year after cardiac arrest demonstrated no benefit of lower oxygenation targets compared with higher oxygenation targets, nor was any benefit observed in 1-year survival [22,23]. For neurologically favorable survival at 3 or 6 months, two randomized controlled trials involving 1,059 patients [21,22] and one subgroup analysis [20] similarly showed no advantage of lower oxygenation targets. With respect to survival at hospital discharge or at 28 or 30 days, two randomized controlled trials involving 1,409

patients [21,22] and two subgroup analyses [19,20] demonstrated no benefit of lower oxygenation targets over higher oxygenation targets.

In summary, studies comparing lower and higher oxygenation targets after ICU admission did not demonstrate a clear benefit of targeting lower oxygenation levels. Therefore, lower oxygenation levels do not have clinically meaningful advantages over higher oxygenation levels.

Hypocapnia reduces the cerebral blood flow and may exacerbate secondary brain injury. Although hypercapnia theoretically increases cerebral blood flow, no studies have demonstrated improvements in neurological outcomes associated with this strategy. Three randomized controlled trials comparing ventilatory strategies targeting moderate hypercapnia versus normocapnia in adult patients who achieved ROSC in a prehospital setting were included in a meta-analysis. In newly added trials, ventilatory targets included PaCO<sub>2</sub> of 50–55 mmHg vs. 35–45 mmHg, and approximately 44–45 mmHg vs. 34–35 mmHg [21,24,25].

With respect to survival at hospital discharge, three randomized controlled trials involving 1,866 patients demonstrated no benefit of ventilatory strategies targeting moderate hypercapnia compared with normocapnia [21,24,25]. Similarly, analysis of neurologically favorable survival at 6 months in three randomized controlled trials involving 1,751 patients showed no advantage of moderate hypercapnia over normocapnia [21,24,25].

In conclusion, studies comparing ventilatory strategies targeting moderate hypercapnia with those targeting normocapnia in adult patients after ROSC did not demonstrate clear benefits in terms of survival or neurologically favorable survival [21,24,25]. Therefore, maintenance of PaCO<sub>2</sub> within the normal range of 35 to 45 mmHg is recommended in adult patients who achieve ROSC after cardiac arrest.

### Hemodynamic management

Previous guidelines have recommended prompt correction of hypotension (systolic blood pressure  $\leq$  90 mmHg or mean arterial pressure [MAP]  $\leq$  65 mmHg) after ROSC and maintenance of systolic blood pressure  $\geq$  100 mmHg [26]. The 2021 European Resuscitation Council Guidelines similarly supported these recommendations based on the results of three clinical trials [27–30].

Subsequently, a meta-analysis published in 2024 evaluated four studies comparing standard care targeting a MAP of 60 to 65 mmHg or higher with goal-directed therapy targeting a MAP of  $\geq$  71 mmHg [31]. Based on these findings, the 2024 European Resuscitation Council Recommendations concluded that evidence supporting maintenance of MAP targets higher than 60 to 65

mmHg was insufficient. In contrast, a recent statement jointly issued by the American Heart Association and the Neurocritical Care Society recommended maintaining a MAP of  $\geq$  80 mmHg after ROSC in patients with cardiac arrest.

Small observational and retrospective studies have attempted patient-specific approaches to MAP targeting, based on the assessment of cerebral autoregulation using cerebral oxygen saturation and pressure measurements. These studies suggested that a MAP  $\geq$  85 mmHg should be maintained in patients with preserved autoregulation, whereas a MAP  $\geq$  100 mmHg may be required in patients without preserved autoregulation [32]. Another small observational study proposed maintaining a MAP  $\geq$  89 mmHg in both groups [33]. However, no prospective studies to date have demonstrated a direct effect of autoregulation-guided MAP targets on neurological recovery.

Studies attempting individualized management using brain tissue oxygenation and transcranial Doppler ultrasonography are ongoing. However, these techniques remain limited by operator dependence, challenges in interpretation, and the inability to obtain continuous measurements, restricting their widespread application in clinical practice [34,35].

Based on the available evidence, the 2025 Korean guidelines suggest avoidance of hypotension and maintenance of a target MAP of at least 60 to 65 mmHg in adult patients who achieve ROSC after OHCA. Higher MAP targets may be required in selected patient populations, such as those with chronic hypertension or signs of persistent peripheral hypoperfusion (e.g., anuria or persistently elevated lactate levels).

### Coronary angiography

In coronary angiographic evaluations of patients presenting with OHCA, significant coronary lesions have been observed in approximately 40% to 60% of patients [36–39], and the proportion of patients who subsequently underwent coronary revascularization in these studies ranged from 30% to 40%.

Since the publication of the COACT trial in 2019 [40], several prospective randomized controlled trials comparing immediate (or early) versus delayed coronary angiography in adult patients with OHCA after ROSC have been reported, including the DISCO [41], PEARL [36], TOMAHAWK [39], EMERGE [38], and COUPE trials [42]. All of these studies enrolled patients without ST-segment elevation on post-ROSC ECG. Some trials included only patients with shockable initial rhythms (COACT), whereas others included patients with both shockable and nonshockable rhythms. In certain studies, the level of consciousness was not explicitly specified in the inclusion criteria (TOMAHAWK, EMERGE); however, in both

studies, the median GCS score of the enrolled patients was 3.

Across all trials and their 1-year follow-up analyses [37,43], immediate coronary angiography in comatose adult patients without ST-segment elevation after ROSC did not improve short- or mid- to long-term outcomes, regardless of the initial cardiac rhythm. These findings have also been confirmed by a meta-analysis [44].

Based on this evidence, the 2025 Korean guidelines do not recommend routine early coronary angiography in comatose adult patients without ST-segment elevation who achieve ROSC after OHCA. Although the timing of coronary angiography may be individualized, the procedure should be performed after hemodynamic stabilization or neurological recovery. However, coronary angiography should be considered when any of the following are present, even in the absence of initial ST-segment elevation: newly developed ST-segment elevation or new left bundle branch block equivalent changes on ECG; development or progression of cardiogenic shock; or electrical instability due to recurrent ventricular fibrillation or ventricular tachycardia. These conditions corresponded to the exclusion criteria of the trials or indications for emergency angiography in the delayed angiography arm.

Considering the well-established importance of early coronary reperfusion in ST-segment elevation myocardial infarction and cardiogenic shock due to acute coronary syndrome [45,46], emergent coronary angiography is recommended in unresponsive adult patients after ROSC when there is evidence of ST-segment elevation or cardiogenic shock. This recommendation is consistent with the 2025 American College of Cardiology/American Heart Association Guidelines for Acute Coronary Syndromes, which advocate primary percutaneous coronary intervention in post-cardiac arrest patients with ST-segment elevation who are comatose but have a reasonable likelihood of favorable neurological outcomes and emergent revascularization in patients with cardiogenic shock, regardless of ST-segment elevation [47].

### Targeted temperature management

In a recent systematic review conducted by ILCOR, no differences in survival or neurological outcomes were observed according to the use of hypothermia, timing of initiation, target temperature, duration of temperature control, methods of temperature management, or rewarming rates in comatose post-cardiac arrest patients after ROSC [48].

Another ILCOR systematic review comparing TTM with subnormal target temperatures to TTM with normothermic targets or fever prevention strategies found no differences in survival or neurological outcomes among patients with hypothermia, nor-

mothermia, or fever prevention [49–55]. Based on these findings, ILCOR suggests fever prevention with a target temperature of  $\leq 37.5^{\circ}\text{C}$  in comatose patients after ROSC. However, considering that individual randomized trials and systematic reviews have suggested potential neurological benefits of TTM [52,54–56], and that the recommendation for fever prevention alone may lead to the perception that TTM is unnecessary, the 2025 Korean guidelines recommend performing TTM in comatose adult cardiac arrest survivors after ROSC. It is further recommended not to actively rewarm patients to normothermia if they are hypothermic after ROSC.

### Target temperature and duration

ILCOR systematic reviews evaluating differences in outcomes between various target temperature ranges ( $33^{\circ}\text{C}$  vs.  $36^{\circ}\text{C}$ ,  $32^{\circ}\text{C}$  vs.  $34^{\circ}\text{C}$ ,  $33^{\circ}\text{C}$  vs.  $34^{\circ}\text{C}$ ,  $32^{\circ}\text{C}$  vs.  $33^{\circ}\text{C}$ , and  $31^{\circ}\text{C}$  vs.  $34^{\circ}\text{C}$ ) found no differences in survival or neurological outcomes [57–61]. Considering the fever prevention recommendation by ILCOR, target temperatures used in major TTM trials, and data from the Korean Society of Hypothermia Therapy, where  $32^{\circ}\text{C}$  is rarely used in clinical practice, the 2025 Korean guidelines recommend selecting a target temperature between 33 and  $37.5^{\circ}\text{C}$  when performing TTM. One randomized trial suggested that targeting  $33^{\circ}\text{C}$  may be beneficial compared with  $37^{\circ}\text{C}$  in patients with nonshockable initial rhythms [52]. Although it remains unclear whether specific subgroups derive benefits from subnormal target temperatures, a target temperature of  $33^{\circ}\text{C}$  is suggested for OHCA patients with nonshockable rhythms undergoing TTM.

The ILCOR systematic reviews demonstrated no differences in survival or neurological outcomes between maintenance durations of 12–24 hours vs. 36 hours or 24 hours vs. 48 hours [62,63]. Therefore, it is recommended to maintain the target temperature for at least 24 hours.

### Methods of TTM

The ILCOR systematic reviews found no differences in survival or neurological outcomes between intravascular cooling catheters and surface cooling methods [64–66]. The 2025 Korean guidelines suggest using either surface cooling or intravascular cooling catheters in comatose post-cardiac arrest patients undergoing TTM. When temperature control devices are used, systems equipped with continuous core temperature feedback are recommended to maintain stable target temperatures.

### Rewarming rate

The 2020 Korean guidelines suggested a rewarming rate of 0.25

to 0.5 °C/hr, based on previous clinical trials, due to insufficient evidence [26]. A randomized trial comparing rewarming rates of 0.25 and 0.5 °C/hr in OHCA patients showed no differences in 90-day survival or favorable neurological outcomes [67]. Further studies are required to determine optimal rewarming rates.

#### *Fever prevention after TTM*

In a randomized trial involving 789 adult OHCA patients, temperature control at 36 °C for 24 hours followed by fever prevention targeting 37 °C for either 48 hours or until awakening (total 72 hours) was compared with fever prevention for 12 hours or until awakening (total 36 hours). No differences were observed in 90-day survival or favorable neurological outcomes between the two strategies [68]. Therefore, in comatose cardiac arrest patients, active fever prevention for 36 to 72 hours is recommended.

#### *Prehospital cooling*

The ILCOR systematic review showed no differences in survival or neurological outcomes between patients who received prehospital cooling and those who did not [69–78]. No available evidence indicates that prehospital cooling improves outcomes in cardiac arrest patients, and studies suggest that rapid infusion of large volumes of cold intravenous fluids in the prehospital setting may impair ROSC or increase the risk of recurrent cardiac arrest [71,72]. Accordingly, the 2025 Korean guidelines do not recommend routine prehospital cooling using large-volume cold intravenous fluids.

### **Other critical care management**

#### *Glycemic control*

Hyperglycemia is common in OHCA patients after ROSC and has been associated with increased mortality and poor neurological outcomes. Continuous insulin infusion is the most effective method for glycemic control. No new studies on post-cardiac arrest glucose management have been published since the 2020 Korean guidelines. Therefore, a target blood glucose range of 144 to 180 mg/dL is suggested after ROSC, and immediate correction with glucose solutions is recommended in cases of hypoglycemia.

#### *Seizure management*

Seizures, nonconvulsive status epilepticus, and other seizure-like activities occur in approximately 20% to 30% of comatose post-cardiac arrest patients [79]. Seizures can be detected clinically or on an EEG. In 2021, the American Clinical Neurophysiology Society published standardized criteria for possible or definite electrographic seizure activity [80].

Currently, there is no evidence that any specific antiepileptic drug or combination of drugs improves the outcomes of post-cardiac arrest seizures. Nevertheless, aggressive treatment is recommended to prevent secondary brain injury. EEG should be performed when seizures are suspected or observed. Given the high incidence of nonconvulsive seizures and the frequent use of sedation, neuromuscular blockers, or TTM, continuous EEG monitoring is recommended when clinical assessment is limited.

Commonly used antiepileptic agents administered as rapid infusions include fosphenytoin, valproate sodium, and levetiracetam. Sedatives, such as propofol or midazolam, are also effective in suppressing post-cardiac arrest seizure activity. Thiopental or phenobarbital should be considered for selected patients. To date, no randomized controlled trials have evaluated the treatment of clinical seizures after cardiac arrest.

In one randomized controlled trial, comatose post-cardiac arrest patients with rhythmic and periodic EEG patterns were randomized to receive antiseizure treatment or no treatment, and no differences were observed in favorable neurological outcomes or survival at 3 months [81]. Although it remains unclear whether rhythmic and periodic patterns represent irreversible injury or treatable conditions, seizures within the ictal-interictal continuum are associated with secondary brain injury and should be treated. Observational studies have reported favorable neurological outcomes in 4% to 44% of patients with status epilepticus after cardiac arrest [82–85]. These patients often received multiple antiepileptic agents and experienced delayed awakening. Therefore, aggressive treatment with multiple antiepileptic drugs is warranted when clinical or electrographic seizures or status epilepticus are present. Prophylactic antiseizure medications are not recommended to prevent post-cardiac arrest epilepsy.

#### *Sedation*

Mechanical ventilation is frequently required immediately after ROSC, necessitating the intermittent or continuous administration of sedatives and analgesics. During TTM, sedation is also used to prevent or reduce shivering, thereby facilitating a more rapid achievement of the target temperature. In such cases, the use of protocols to assess and maintain appropriate sedation depth is beneficial.

Short-acting agents, such as propofol, dexmedetomidine, and remifentanyl, facilitate reliable neurological assessment and prognostication. In one randomized trial comparing propofol plus remifentanyl with midazolam plus fentanyl, the time to awakening was shorter in the propofol-remifentanyl group, although the norepinephrine requirements were higher [86]. Therefore, seda-

tion and analgesia with short-acting agents are recommended.

A systematic review reported higher survival rates with continuous prophylactic neuromuscular blockade than with no neuromuscular blockade; however, most of the included studies were retrospective [87]. Accordingly, routine prophylactic neuromuscular blockade is not recommended.

#### *Prophylactic antibiotics*

Patients with post-cardiac arrest syndrome are at a high risk of aspiration and ventilator-associated pneumonia, leading some institutions to routinely administer prophylactic antibiotics. The 2020 Korean guidelines, based on analyses of randomized and observational studies, do not recommend routine prophylactic antibiotic use. No new studies have been published since then. Therefore, routine prophylactic antibiotic administration is not recommended in comatose patients after cardiac arrest.

#### *Steroids*

In a single-center Greek study published in 2009, the administration of vasopressin, methylprednisolone, and epinephrine during cardiopulmonary resuscitation, followed by hydrocortisone after ROSC, significantly improved survival to hospital discharge compared with placebo in in-hospital cardiac arrest patients [88]. Subsequent multicenter Greek trials have also demonstrated improved survival [89]. However, a US randomized trial involving patients with shock after in-hospital cardiac arrest or OHCA found no benefit from continuous hydrocortisone administration [90]. A meta-analysis of these three randomized trials focusing on in-hospital cardiac arrest patients showed improved rates of ROSC, but no improvement in survival or neurological outcomes [91].

More recently, a randomized, double-blind trial (CORTICA) conducted at two Greek centers evaluated low-dose hydrocortisone in patients with in-hospital cardiac arrest who received methylprednisolone during cardiopulmonary resuscitation (CPR) and required vasopressors after ROSC. No significant differences in the outcomes were observed between the intervention and control groups [92].

In conclusion, based on currently available clinical trial evidence, there is insufficient evidence to recommend steroid therapy in comatose survivors of cardiac arrest, and routine steroid use is not recommended.

## POOR NEUROLOGICAL OUTCOME PREDICTION

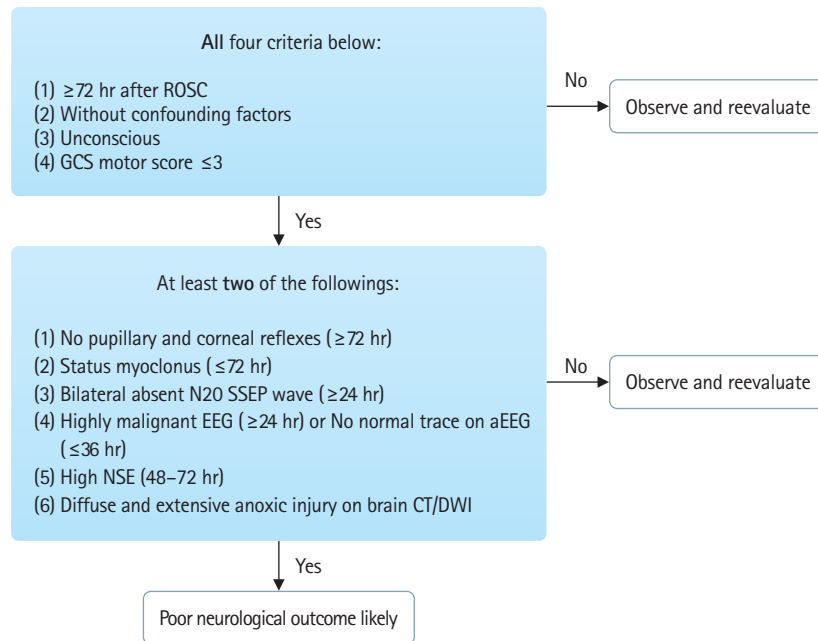
Approximately two-thirds of in-hospital deaths in patients ad-

mitted to the ICU after resuscitation from OHCA are caused by hypoxia-ischemic brain injury. Although some die from irreversible brain damage or brain death directly resulting from hypoxia-ischemic brain injury, most patients die from the withdrawal of life-sustaining treatments. Therefore, accurate prediction of neurological outcomes is crucial to prevent inappropriate withdrawal of life-sustaining treatments in patients who still have a chance of neurological recovery, and to reduce unnecessary treatment in patients with severe and irreversible brain injury. The 2025 Korean guidelines propose the following approach for predicting neurological outcomes (Fig. 2).

#### **Neurological examination**

Although the pupillary light reflex has the advantage of being easily performed at the patient's bedside, it has the disadvantage of being influenced by medications such as sedatives and muscle relaxants. The absence of the pupillary light reflex immediately after ROSC and 24 hours after ROSC has low specificity for predicting poor neurological outcomes and is therefore not recommended. Most observational studies have reported 100% or near 100% specificity for the absence of the pupillary light reflex at 72 hours, suggesting its potential use as a tool for predicting neurological outcomes [93–120]. Automated pupillary light reflex (PLR) measures two variables: the quantitative PLR (qPLR; the percentage of pupillary constriction) and the neurological pupil index (NPI), which is based on several variables such as pupil size, constriction ratio, constriction velocity, and latency.

Several observational studies have reported on the predictive power of qPLRs for neurological outcomes [98,103,121–123]. A qPLR of 0% to 13% within 24, 48, and 72 hours was reported to predict poor neurological outcome at 3 to 12 months with a specificity of 77.8% to 100%. In two other observational studies, qPLR between days 1 and 3 predicted poor neurological outcomes at 90 days with a specificity of 100% and a sensitivity of 19% to 28% [122,123]. Several observational studies have reported the predictive power of the NPI for neurological outcomes [103,122–126]. A 24-hour NPI of 0 to 2.40 predicted poor neurological outcome from hospital discharge to 3 months later, with a specificity of 100% and a sensitivity of 22% to 43.9% [103,124,125]. NPI  $\leq 2$  within 48 or 72 hours predicted poor neurological outcome at 3 months, with a specificity of 100%, and a sensitivity of 18.8% and 16.9%, respectively [103]. In three other observational studies, NPI between days 1 and 3 predicted poor neurological outcomes at 90 days and 3 months, with a specificity of 100% and a sensitivity of 9% to 17% [122,123,126]. Therefore, quantitative pupillometry is suggested to predict poor neu-



**Fig. 2.** Algorithm for prognostication after cardiac arrest. ROSC, return of spontaneous circulation; GCS, Glasgow Coma Scale; SSEP, somatosensory evoked potential; EEG, electroencephalography; aEEG, amplitude-integrated electroencephalography; NSE, neuron-specific enolase; CT, computed tomography; DWI, diffusion-weighted imaging.

rological outcomes 72 hours after ROSC in comatose patients following cardiac arrest. An absent or extensor motor response (motor score 1 or 2 on the GCS) was associated with poor neurological outcomes. However, its specificity is low, and even at 96 hours after ROSC, it fails to predict poor neurological outcomes with 100% accuracy. Furthermore, it is affected by neuromuscular blocking agents and is, therefore, not recommended as a prognostic tool.

Brainstem reflexes, such as pupillary reflexes, have the advantage of being easily performed at the patient's bedside. However, they are affected by sedatives and muscle relaxants. The absence of a corneal reflex immediately after ROSC or 24 hours after ROSC has low specificity for predicting a poor neurological outcome and is therefore not recommended. Most observational studies report that the absence of corneal reflex at 72 hours has a specificity of 100% or near 100%, suggesting its potential use as a tool for predicting neurological outcomes [93,94,96,98,99,104–106,109–112,114,115,117–120].

Myoclonus consists of sudden, brief, involuntary movements caused by muscle contraction or inhibition and can be focal, multiple, or generalized. Most observational studies have shown that the development of myoclonus within 96 hours of ROSC is associated with a poor neurological outcome; however, false-positive rates of up to 22% have been reported [94,101,105,111,119,127–130]. Clinical myoclonus may or may not be associated with

electrographic seizures. Therefore, EEG recordings are required. Status myoclonus is defined as continuous, generalized myoclonus lasting for more than 30 minutes. The presence of status myoclonus within 72 hours predicted poor neurological outcomes from hospital discharge to 6 months, with a specificity of 94% to 100% and a sensitivity of 30.6% to 56.0% [96,131,132]. Therefore, we suggest using myoclonus or status myoclonus along with other tests within 96 hours of ROSC. Furthermore, we suggest performing EEG recordings in the presence of myoclonus to detect the associated epileptiform discharges.

## Electrophysiological examination

### *Somatosensory evoked potential*

Somatosensory evoked potentials can be suppressed by barbiturates but are maintained under general sedation [133]. Bilateral absence of the N20 wave is a reliable predictor of poor neurological outcomes with high specificity regardless of the timing of measurement [93,103,111–113,115,134–144]. Considering the possibility of confounding factors, we propose using the bilateral absence of the N20 wave at 24 hours after cardiac arrest as a prognostic tool. Bilateral absence of the N20 wave has been reported to be a false-positive predictor of poor outcomes [145]. Low-amplitude N20 wave can predict a poor outcome with higher sensitivity and similar specificity as the bilateral absence of the N20 wave [139,146–151], and the N20 amplitude threshold for

predicting 100% specificity has been reported to be 0.5  $\mu$ V. However, various thresholds have been proposed, and the potential interference from sedation and low-amplitude N20 is not recommended for predicting poor neurological outcomes after cardiac arrest.

### *Electroencephalography*

EEG is a crucial diagnostic tool for assessing brain function and outcomes after cardiac arrest and for diagnosing seizures. The key EEG components for assessing neurological outcomes include background activity, superimposed discharges, and reactivity. Among these, background continuity is the most important for outcome and is generally classified as continuous (amplitude  $\geq 20$   $\mu$ V in  $\geq 90\%$  of the background wave), discontinuous (attenuation [ $< 20$   $\mu$ V] or suppression [ $< 10$   $\mu$ V] in 10%–49% of the background wave), burst suppression ( $< 10$   $\mu$ V in 50%–99%), or suppression ( $< 10$   $\mu$ V in  $\geq 99\%$ ) [152]. In many patients, immediately after cardiac arrest, background EEG signals are suppressed, discontinuous, and of low voltage [153,154]. Most patients with a good outcome recover to a continuous, normal-voltage EEG within the first 24 hours, and the timing of this recovery is associated with the outcome [152,154–156]. Sedatives affect the continuity of background EEG and can induce a discontinuous or burst-suppressed background in a dose-dependent manner [157,158].

#### 1) Background EEG pattern

##### (1) Suppression

Suppression ( $< 10$   $\mu$ V) or low-voltage ( $< 20$   $\mu$ V) background EEG is relatively common during the first day after cardiac arrest [80,154,155]. However, a background EEG suppression of  $< 10$   $\mu$ V at 24 hours is considered a reliable indicator of poor neurological outcome [140,159–163]. Suppression with periodic discharges is associated with a poorer neurological outcome than suppression without periodic discharge and is less sensitive to the time of onset.

##### (2) Burst suppression

Burst suppression is defined as 50% to 99% of the recording consisting of suppression alternating with bursts [80]. Burst suppression is highly specific for poor neurological outcomes, particularly after 24 hours [95,162–164]. Depending on the appearance of the burst, it can be further defined as highly epileptiform bursts or identical bursts. These burst suppression patterns are more specific for poor neurological outcomes than burst suppression with various burst patterns and are less sensitive to the time

of onset [165]. Although good neurological outcomes have been reported despite burst suppression, these outcomes may be due to the influence of sedatives or inappropriate interpretations [154,161–163,166].

#### (3) Reactivity

Reactivity means that the amplitude or frequency of EEG waves changes significantly in response to external stimuli such as sound or pain. Interrater agreement for EEG reactivity has been reported to vary considerably [161,167]. Although an international consensus on reactivity assessment methods has been proposed [168], it is based on unclear or varied criteria, and the suggested prognostic value also varies considerably across studies [169,170]. Absence of EEG reactivity within 24 hours of cardiac arrest has high sensitivity but low specificity for predicting poor neurological outcomes [136,171–173]. After 24 hours, sensitivity remains high, but specificity is reported to vary from 50% to 100% [94,111,136,161,163,171,173–175].

#### 2) Superimposed patterns

##### (1) Periodic discharges

A periodic pattern is a waveform in which discharges repeatedly appear at regular intervals [80]. Generalized periodic discharges are a poor prognostic indicator; however, their specificity is limited [159,162,163,174]. In general, background EEG is more closely related to neurological outcomes [152]; therefore, periodic discharges appearing in a continuous, reactive background should not be used as a poor prognostic indicator [156,176].

##### (2) Sporadic epileptiform discharges

Sporadic epileptiform discharges are sharp waves or spikes that appear irregularly, similar to those observed in patients with epilepsy. It can occur at varying frequencies, ranging from rare ( $< 1$  per hour) to abundant ( $\geq 1$  per 10 seconds). The presence of sporadic epileptiform discharges is generally associated with poor neurological outcomes; however, their specificity has been reported to range from 66.7% to 100% [169], and their frequency and number are poorly reported [140,159,161]. Therefore, the presence of sporadic epileptiform discharges is not a reliable indicator of poor neurological outcome.

##### (3) Electrographic seizures

The American Clinical Neurophysiology Society (ACNS) defines unequivocal seizures as epileptiform discharges exceeding 2.5 Hz lasting 10 seconds or longer, or exhibiting a definite evolution in frequency, shape, or location lasting 10 seconds or longer [80].

Although it has shown low sensitivity and high specificity for predicting poor neurological outcomes regardless of the time of onset, the definition has not been consistently applied across studies, and consideration of the EEG background is crucial [127,159,161,163,174].

#### (4) Electrographic status epilepticus

According to the 2021 ACNS Terminology Update, electrographic status epilepticus is defined as an electrographic seizure lasting 10 minutes or longer, or more than 20% over a 60-minute period. The criteria used to assess electrographic status epilepticus have been inconsistent across studies, and some have not specified a definition [84,96,100,156,171,174]. Several observational studies have shown that electrographic status epilepticus of less than 5 days predicts poor neurological outcomes up to 6 months after discharge, with a specificity of 82.6% to 100% and a sensitivity of 1.8% to 50% [84,96,100,156,171,174]. In one study, the specificity was 100% only when electrographic status epilepticus occurred against a background of discontinuous or burst suppression [84]. Due to the lack of a standardized classification, it is recommended to distinguish between the EEG background, superimposed discharge, and definite seizures according to the ACNS Standardized Critical Care EEG Terminology rather than using the term electrographic status epilepticus for prognostic assessment [80].

#### (5) Highly malignant EEG pattern

Several observational studies have reported an association between highly malignant EEG patterns and neurological outcomes. Although there are some differences depending on the time of onset, the specificity has been reported to be 90.6% to 100% [94,136,141,157,162,163,172,173]. Westhall et al. [163] proposed the following classification based on the ACNS Standardized Critical Care EEG Terminology, and this guideline also suggests following this classification (Fig. 3):

##### (1) Highly malignant EEG

- Suppressed background without discharge
- Suppressed background with continuous periodic discharge
- Burst suppression background with or without discharge

##### (2) Malignant EEG

- Malignant periodic or rhythmic patterns (abundant periodic discharges; abundant rhythmic polyspike, spike, sharp-and-wave; and unequivocal electrographic seizures)
- Malignant background (discontinuous background, low-voltage background, and reversed anteroposterior gradient)

(3) Unreactive EEG (absence of background reactivity or stimulus-induced discharge)

##### (4) Benign EEG

- Absence of all the malignant features stated above

#### 3) Quantitative EEG indices

Various quantitative EEG indices have also been investigated [177,178]. Although the evidence is limited, considering the ease of application and interpretation, failure to return to a continuous normal amplitude pattern within 36 hours on amplitude-integrated EEG monitoring, along with other poor prognostic factors, can be used to predict poor neurological outcomes. The threshold and specificity of the bispectral index, a quantitative index that integrates various elements of EEG for predicting poor neurological outcomes, vary greatly across studies, and therefore, it is not recommended as a prognostic tool [156,179–181].

#### Biomarkers

Biomarkers have the advantages of providing quantitative results, being relatively easy to sample and interpret, and not being affected by sedatives. However, they have the disadvantages of limited clinical utility and a lack of standardized analytical methods.

##### *Neuron-specific enolase*

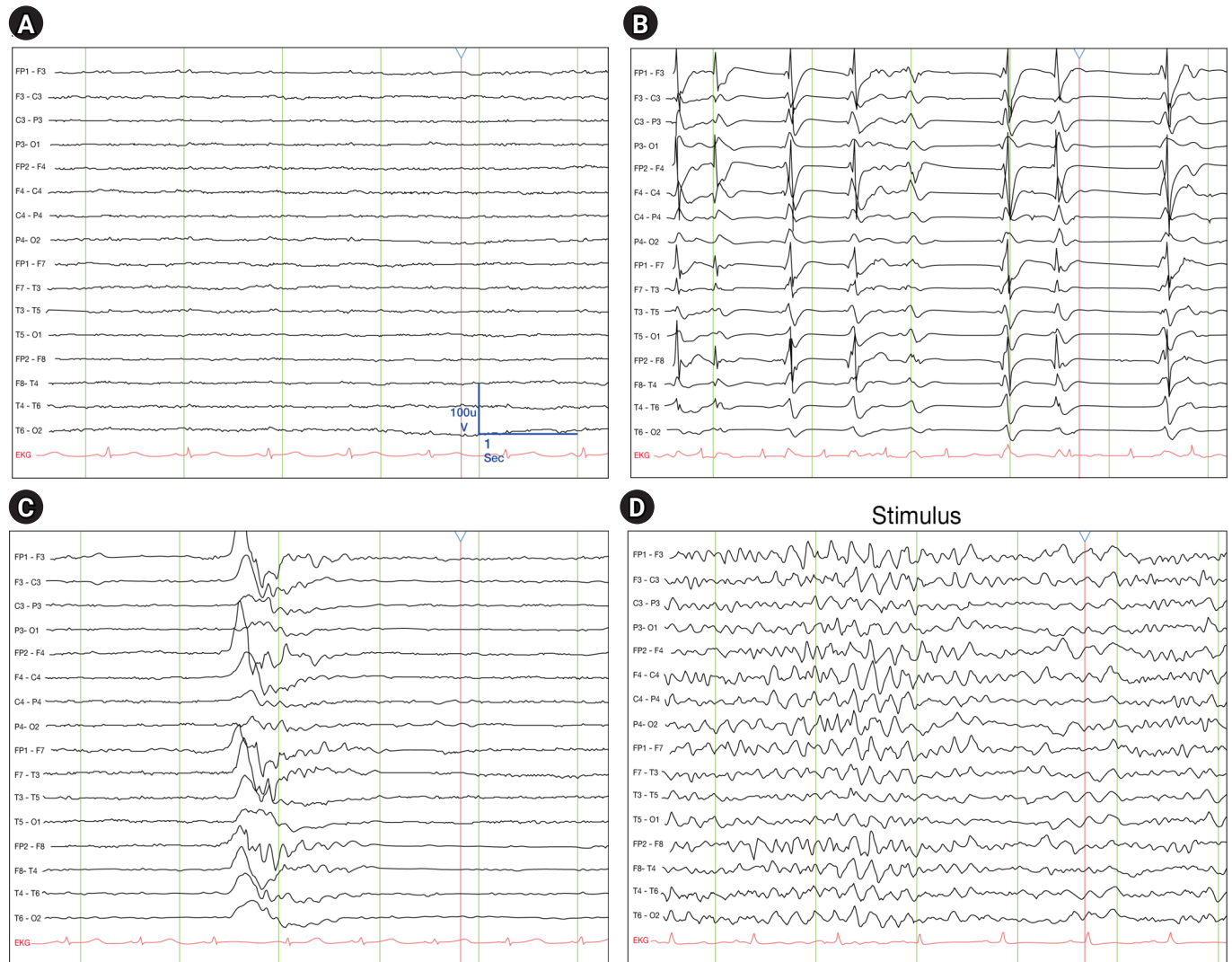
NSE is the most extensively studied biomarker [131,182–198]. The 2021 European guidelines proposed a threshold of NSE of 60 µg/L at 48 or 72 hours [27]. A validation study in 660 patients with a GCS motor score of 1 to 3 at 72 hours after ROSC showed that NSE > 60 µg/L was associated with a poor neurological outcome with 100% specificity [199]. However, the threshold for predicting poor neurological outcomes varies across studies, making it difficult to provide a definitive cutoff value. Therefore, we propose the use of NSE in combination with other tests within 72 hours of ROSC to predict neurological outcomes.

##### *S100B protein*

Two studies have evaluated its prognostic predictive ability [182,200]. These two studies demonstrated variable thresholds and low sensitivity. Therefore, the S100B level is not recommended as a prognostic tool.

##### *Glial fibrillary acidic protein*

Five studies measured GFAP levels between 12 and 72 hours after ROSC to predict neurological outcomes [183,185,200–203]. In these studies, high GFAP levels were associated with poor neuro-



**Fig. 3.** Electroencephalography (EEG) patterns according to the American Clinical Neurophysiology Society's Standardized Critical Care EEG Terminology: (A–C) highly malignant pattern and (D) benign patterns. (A) Suppressed background (<10  $\mu$ V) without discharges. (B) Suppressed background with continuous periodic discharges. (C) Burst suppression background without discharges with suppression periods (amplitude <10  $\mu$ V) constituting >50% of the recording. (D) Continuous normal-voltage EEG with reactivity (>20  $\mu$ V).

logical outcomes, with specificity ranging from 98% to 100%. However, the thresholds varied widely.

#### *Serum tau protein*

Three studies measured serum tau protein concentrations between 12 and 72 hours after ROSC to predict neurological outcomes in comatose patients following cardiac arrest [183,200,202]. Similar to GFAP, elevated tau protein levels were associated with poor neurological outcomes, with specificity ranging from 99% to 100%, but with widely varying thresholds.

#### *Neurofilament light chain*

Seven studies measured neurofilament light chain (NfL) concentrations between 12 and 72 hours after ROSC to predict neurological outcomes in comatose patients following cardiac arrest [192,195,200,203–206]. Despite specificity ranging from 99% to 100%, varying thresholds were used.

Novel biomarkers, such as NfL, GFAP, and tau protein, are present in extremely low amounts in normal individuals compared to the traditional biomarker NSE; therefore, an analytical method that can detect picogram-scale proteins is needed. This method has several limitations, including high costs and limited laboratory analyses in Korea. Therefore, the guidelines do not recommend

these novel biomarkers as tools for predicting neurological outcomes.

### Neuroimaging

When restricted diffusion is not observed on DWI performed between 72 hours and 7 days after ROSC, this may suggest a good neurological outcome. If the lesion is absent or localized, the likelihood of a good recovery is increased. Imaging findings should be interpreted comprehensively along with EEG, neurological examination, and biomarkers [93,207–209].

Imaging findings suggesting a poor neurological outcome include a marked decrease in the GWR on brain CT, widespread diffusion restriction on DWI MRI, and a high volume fraction of areas with low apparent diffusion coefficient (ADC) values on quantitative analysis [210–223]. A GWR of  $\leq 1.23$  has been used as a strong indicator of poor outcome (Cerebral Performance Categories 3–5) in several studies, with most showing 100% specificity but with sensitivity varying from 13% to 84% [210,212–214]. GWR is used as an indirect indicator of cerebral edema and requires careful interpretation depending on the timing of imaging. The prognostic value is higher when CT is performed between 48 and 96 hours after ROSC than immediately after ROSC. If the initial CT findings are inconclusive, monitoring changes in the GWR through follow-up CT is beneficial [219]. This guideline suggests the use of the GWR on brain CT to predict poor neurological outcomes in adults in a coma after cardiac arrest. However, a GWR threshold with 100% specificity has not been recommended. Calculation of the GWR using an automated algorithm outperformed manual measurements in terms of area under the curve, sensitivity, and specificity [93,219–222].

DWI is an imaging technique sensitive to ischemic damage. Bilaterally symmetric and extensive lesions, especially those with widespread diffusion restriction in the cortex, thalamus, and basal ganglia, are associated with a high likelihood of poor outcomes [99,110,215–217]. Therefore, the use of DWI in brain MRI is suggested to predict poor neurological outcomes. ADC analysis is typically interpreted based on the volume fraction of voxels below a cutoff point, rather than the average value. A brain with an ADC of  $600 \times 10^{-6} \text{ mm}^2/\text{sec}$  or less in the proportion of voxels greater than 13% or  $420 \times 10^{-6} \text{ mm}^2/\text{sec}$  or less in the proportion of voxels greater than 3% is associated with a poor outcome [217,218,223,224].

Regions of diffusion restriction or low ADC on DWI are mainly observed in the bilateral parietal lobes, occipital lobes, and around the central sulcus. Anatomical distribution analysis can also help assess outcomes [110,216,225]. The use of ADC on brain

MRI has been proposed to predict poor neurological outcomes in comatose adults after cardiac arrest. The sensitivity and specificity of DWI vary depending on the acquisition time point. Brain MRI performed between 72 hours and 7 days after cardiac arrest is likely to indicate a good outcome if diffusion restriction does not extend widely to the cortex and deep gray matter. However, some patients still have poor neurological outcomes [217,218,223,224,226]. DWI obtained within 6 hours of ROSC can also be used as a sensitive imaging tool to reflect changes in the early stages of lesion development. At this point, the presence of diffusion restriction in the cortex or deep gray matter, regardless of its size, is interpreted as a finding suggesting a poor neurological outcome, and even if lesions are not visible, it does not necessarily mean a good outcome. In some patients, lesions may form over time, so it is necessary to confirm whether diffusion restriction has spread widely, including the cortex and deep gray matter, through reimaging at 72 to 96 hours [217,223,224,226].

## GOOD NEUROLOGICAL OUTCOME PREDICTION

Predicting good neurological outcomes has advantages. First, it reduces prognostic uncertainty. Second, it provides reassurance to the patients' families. Third, it can guide decisions regarding continued intensive care. Finally, it counteracts false pessimistic signals from factors that predict poor neurological outcomes [169,227]. Signs that predict a good neurological outcome include the following:

- (1) GCS motor score of 4 or higher within 4 days after ROSC.
- (2) Normal blood NSE concentration ( $< 17 \text{ } \mu\text{g/L}$ ) within 72 hours after ROSC.
- (3) No diffusion restriction observed on MRI obtained between 2 and 7 days after ROSC.
- (4) Continuous or nearly continuous normal-voltage background EEG without periodic discharges or seizures within 72 hours after ROSC.
- (5) High-amplitude N20 ( $> 4 \text{ } \mu\text{V}$ ) in somatosensory evoked potentials.
- (6) Normal blood NfL concentration ( $< 55 \text{ pg/mL}$ ) between 24 and 72 hours after ROSC.

Of these factors, (1)–(4) have been relatively well studied and can be used to predict good neurological outcomes, as they can minimize the influence of medications such as sedatives.

## ORGAN DONATION AFTER CARDIAC ARREST

CPR is not an obstacle to organ donation. When comparing organs

from donors who received CPR with those from donors who did not, no significant differences in organ function or recipient survival after transplantation have been reported [228]. Therefore, patients who regain spontaneous circulation after cardiac arrest but die are potential candidates for organ donation. Organ donation protocols should be clinically developed and implemented.

Recently, efforts to promote organ donation in patients with cardiac arrest have been actively pursued, particularly in Europe, and various discussions based on the Maastricht classification are underway [229].

The European Resuscitation Council (ERC) emphasizes organ donation from category III patients; however, owing to differences in ethical and legal standards in Korea, this classification cannot be applied there. These guidelines recommend that only patients who regain spontaneous circulation after CPR and are declared brain death should be considered for organ donation.

## REHABILITATION AND RECOVERY AFTER CARDIAC ARREST

Survivors of cardiac arrest experience emotional, social, physical, neurological, and cognitive sequelae [230,231]. In a broad sense, survival encompasses stabilization, rehabilitation, recovery, and reintegration into society. This requires the involvement of families, medical professionals, and communities. The families of cardiac arrest survivors may also experience emotional and social difficulties. These issues significantly affect the quality of life of patients with cardiac arrest; therefore, structured screening assessments for anxiety, depression, posttraumatic stress, and fatigue are recommended. Cognitive impairments in various domains, including memory, concentration, and executive function, are commonly observed after cardiac arrest [232–237]. Therefore, it is recommended that cardiac arrest survivors undergo a comprehensive rehabilitation medical evaluation covering physical, neurological, cardiopulmonary, and cognitive impairments before discharge, and that a treatment plan be developed accordingly. Furthermore, cardiac arrest survivors and their caregivers should develop a multidisciplinary discharge plan that includes rehabilitation treatment and reintegration into society. Emotional problems in cardiac arrest survivors and their caregivers can begin during hospitalization and persist for several years. A comparative study of psychosocial interventions delivered solely to survivors versus those delivered to both survivors and caregivers found that the latter group was more effective [238,239]. Caregivers in the survivor-caregiver group experienced greater improvements in caregiver burden compared to caregivers in the survivor-only

group. Another randomized controlled trial reported improved quality of life in survivors who underwent early cognitive screening and participated in a self-management and referral program compared with survivors receiving usual care [240].

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Conceptualization: SOH; Funding acquisition: SPC; Investigation: all authors; Project administration: SPC; Writing—original draft: TYK, GJA; Writing—review & editing: all authors. All authors read and approved the final manuscript.

### Conflicts of interest

Chun Song Youn, Kyung Woon Jeung, Sang Hoon Oh, Mi Jin Lee, Jisook Lee, Sung Oh Hwang, and Sung Phil Chung are editorial board members of this journal, but were not involved in the peer reviewer selection, evaluation, or decision process of this article. The authors have no other conflicts of interest to declare.

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### Data availability

Data sharing is not applicable as no new data were created or analyzed in this study.

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