



Post-Resuscitation Syndrome: A Multidisciplinary Approach To Therapy

Toshev Izzat Ikromovich

Bukhara State Medical Institute
E-mail: toshev.izzat@bsmi.uz

ABSTRACT

Postresuscitation syndrome (PRS) remains one of the most pressing issues in modern resuscitation and intensive care. Its pathogenesis includes a complex of hypoxic -ischemic, reperfusion , inflammatory and metabolic disorders leading to multiple organ dysfunction in patients after successful cardiopulmonary resuscitation. The main causes of circulatory arrest were acute coronary pathologies and cardiac arrhythmias. The most pronounced clinical manifestations included hypoxic encephalopathy, myocardial dysfunction, infectious complications and metabolic disorders. Complex therapy using targeted temperature therapy, hemodynamic stabilization, nutritional support, infection prevention, cardiological and neurological correction, as well as early rehabilitation has demonstrated a positive effect on treatment outcomes. The importance of a multidisciplinary approach to managing patients with PRS aimed not only at survival but also at restoring quality of life is emphasized. The obtained data are consistent with current international recommendations (AHA, ERC, ESICM, ILCOR) and highlight the need for further research in this area.

Keywords:

post-resuscitation syndrome, cardiac arrest, resuscitation, multidisciplinary therapy, neuroprotection , targeted temperature therapy, rehabilitation

Introduction

Modern advances in intensive care and cardiorespiratory resuscitation have significantly increased the survival rate of patients after cardiac arrest. However, successful resuscitation does not always lead to a full recovery. The number of patients who, after restoration of spontaneous circulation (ROSC - return of spontaneous circulation) are faced with a complex of severe and long-term disorders, united in the concept of post-resuscitation syndrome (PRS, Post-Cardiac Arrest Syndrome (PCAS) [9,10].

Post-resuscitation syndrome is a multi-organ pathological condition that includes four interrelated components:

- post-hypoxic brain injury;
- myocardial dysfunction;
- systemic reperfusion inflammatory response;
- concomitant pathology that led to circulatory arrest or developed during treatment [11,12].

The pathogenesis of PRS includes complex mechanisms of hypoxia- reperfusion , oxidative stress, mitochondrial dysfunction, activation of

apoptosis and inflammatory cascades, which leads to the development of multiple organ failure even with successful resuscitation [1,10].

Taking into account the multifactorial nature post-resuscitation syndrome therapeutic strategies require a multidisciplinary approach, including resuscitators, neurologists, cardiologists, endocrinologists, rehabilitation specialists, psychologists and nutritionists [6].

With the development of cardiorespiratory resuscitation over the past decades, there has been a steady increase in the number of patients surviving cardiac arrest. According to various international registries, survival with in-hospital cardiopulmonary resuscitation reaches 20–25%, and with out-of-hospital resuscitation – about 10–12% [2,11]. However, among survivors, a significant proportion of patients face severe neurological, cardiac and systemic complications, which are combined into the concept of post-resuscitation syndrome.

The pathophysiological mechanisms of PRS are complex and multifactorial. The main trigger is hypoxia- reperfusion tissue injury. In the phase of circulatory arrest, global organ ischemia occurs, and when blood flow is restored, cascades of reperfusion injury are triggered, characterized by the activation of free radical oxidation, inflammatory cytokines, activation of complement and apoptotic pathways [1].

Brain damage is central to the clinical picture of PRS. Hypoxic encephalopathy is manifested by impaired consciousness, cognitive functions, development of coma, epileptic seizures and long-term neurological deficits [12]. The duration and depth of hypoxia during cardiac arrest determine the severity of neuronal damage, especially in the hippocampus, cortex and cerebellum.

Myocardial dysfunction after restoration of blood circulation is characterized by a decrease in myocardial contractility, disruption of coronary microcirculation, and the development of arrhythmias. These disorders are caused by both direct ischemic damage and secondary metabolic and inflammatory changes [9,12].

The systemic inflammatory response (SIRS-like reaction) includes generalized activation of proinflammatory cytokines (IL-6, TNF- α), microcirculation disorder, endothelial dysfunction, and multiple organ failure. Reperfusion syndrome is similar in many aspects to the pathogenesis of sepsis and leads to disruption of homeostasis in many body systems [4].

Concomitant pathology preceding cardiac arrest also contributes to the severity of postresuscitation syndrome. Risk factors include cardiovascular pathology (acute myocardial infarction, arrhythmia), respiratory disorders (pulmonary embolism, hypoxemia), electrolyte disorders, trauma, and severe infections [5,6].

Post-resuscitation syndrome is the result of a complex of pathogenetic processes that require a comprehensive diagnostic and therapeutic approach to increase the chances of full recovery of patients after successful resuscitation.

Effective treatment of post-resuscitation syndrome is impossible without the participation of specialists from various disciplines, since damage in PRS affects almost all body systems. A multidisciplinary approach allows for comprehensive treatment, reducing the risk of complications and improving the patient's prognosis [6]. The main components of this approach are:

The leading role at the initial stage is played by resuscitators and intensive care specialists, providing:

- stabilization of hemodynamics (maintaining adequate blood pressure, organ perfusion);
- optimization of breathing (invasive or non-invasive ventilation with control of PaO₂ and PaCO₂);
- maintaining adequate oxygenation and saturation;
- body temperature control (targeted temperature therapy);
- prevention and treatment of multiple organ failure [Panchal et al., 2020].

Early Neuromonitoring and neurological assessment are of key importance in the

prognosis and treatment of hypoxic encephalopathy:

- conducting EEG, CT/MRI of the brain;
- assessment of coma depth using the Glasgow scale, FOUR scales, etc.;
- early detection of epileptiform activity and convulsive states;
- neuroprotective therapy, including control of temperature, glucose and blood pressure [5].

Given the high prevalence of acute cardiac pathology as a cause of cardiac arrest, the participation of cardiologists is necessary for :

- early assessment and treatment of acute coronary syndrome (interventional procedures, PCI);
- correction of rhythm disturbances (arrhythmia, blockades);
- assessment of myocardial dysfunction (echocardiography, biomarkers - T nT , NT-proBNP);
- management of chronic heart failure [7, 8].

Patients after resuscitation are at high risk of developing infections, which requires:

- early diagnosis and control of infectious complications;
- rational antibacterial therapy;
- monitoring of septic response [3,4].

A long-term critical condition requires the participation of nutritionists and endocrinologists:

- monitoring of glycemic profile and control of hyperglycemia;
- the appointment of early nutritional support (preferably enteral);
- correction of electrolyte disturbances, vitamin status, anemia [13,14].

A multidisciplinary approach is a prerequisite for the successful management of patients with PRS, ensuring not only survival but also maximum restoration of quality of life.

The aim of the study is a comprehensive study of the clinical features, pathogenetic mechanisms and effectiveness of multidisciplinary therapy of post-resuscitation syndrome based on the analysis of clinical observations in patients who have suffered circulatory arrest, taking into account modern

international recommendations and our own clinical experience at the RNCEM BF.

Materials and methods

This study was carried out at the intensive care unit of the Republican Scientific Center for Emergency Medical Care (RSC EMC), Bukhara branch.

The study included 43 patients admitted to the intensive care unit of the Russian Scientific Center of Emergency Medical Care of the Baltic Federal District after successful cardiopulmonary resuscitation in the period 2023–2024. The total number of patients was 43. The average age was 57.3 ± 12.5 years (range 34–79 years). Gender structure: men — 27 (62.8%), women — 16 (37.2%).

Etiology of circulatory arrest:

- Acute coronary event (myocardial infarction) – 21 cases (48.8%).
- Heart rhythm disturbances (VF, VT) – 9 cases (20.9%).
- Pulmonary embolism - 5 cases (11.6%).
- Asphyxia - 3 cases (7.0%).
- Other causes (stroke, severe hypoxemia, trauma) – 5 cases (11.6%).

For a comprehensive assessment of patients, the following were used:

- ✓ clinical and neurological examination;
- ✓ instrumental methods: ECG, echocardiography, CT, MRI of the brain;
- ✓ laboratory parameters: hematological profile, biochemical tests, blood gas composition, blood glucose, levels of myocardial damage markers (troponin , NT- proBNP), brain damage markers (neuron-specific enolase , S-100 β);
- ✓ dynamic assessment of consciousness: Glasgow Consciousness Scale (GCS), FOUR score , CPC;
- ✓ continuous neuromonitoring : EEG;
- ✓ assessment of hemodynamic parameters: heart rate, blood pressure, central venous pressure, cardiohemodynamic parameters ;
- All patients received standardized treatment according to current international recommendations:
- targeted temperature therapy (33–36°C for 24–48 hours);

- infusion therapy and vasopressor support;
- cardiological correction (antiarrhythmic therapy, PCI for infarction);
- nutritional support (enteral nutrition, 1.2–2.0 g/kg protein per day);
- control of hyperglycemia (target range 7.8–10 mmol /L);
- prevention of infections;

Discussion

The study conducted allowed us to further confirm the complexity and multiorgan nature of postresuscitation syndrome in patients after cardiac arrest. The data we obtained are consistent with the results of previously published multicenter studies.

In our cohort, the main etiologic role was played by acute coronary disorders (48.8%), which is fully consistent with the dominant role of acute myocardial infarction in the genesis of out-of-hospital and hospital cardiac arrest according to international registries (50–60%). It is important to note that cardiac arrhythmias (VT, VF) accompanied almost every fifth patient (20.9%), which indicates the importance of early arrhythmological correction in the structure of multidisciplinary therapy.

Posthypoxic encephalopathy was the leading manifestation of PRS in most patients, which is confirmed by the detection of comatose states of varying depth according to the Glasgow scale and FOUR score. As in other studies, some patients had epileptic seizures and epileptiform activity according to EEG data, requiring active anticonvulsant therapy. Such severity of neurological damage is associated, first of all, with the duration of hypoxia and delay in effective cardiopulmonary resuscitation.

The patients in our sample developed myocardial dysfunction of varying severity: decreased LV ejection fraction (according to echocardiography), signs of heart failure, and the need for vasopressor support early after ROSC. These data are consistent with the concept of "stunned myocardium" (myocardium), described in a number of studies.

Special attention in the treatment of our patients was paid to nutritional support. Early initiation of enteral nutrition (within 24–48 hours), sufficient protein supply (1.2–2.0 g/kg/

day), and glycemic control within 7.8–10 mmol /l demonstrated good tolerability and the absence of serious complications. Our results confirm the relevance of current ASPEN/ESPEN recommendations on nutritional support for critically ill patients.

One of the frequent complications of PRS in the studied patients was hospital-acquired infections, primarily mechanical ventilation-associated pneumonia (MVAP), as well as urinary tract infections. This highlights the need for strict adherence to modern infection control protocols in this group of patients.

Despite the relatively good survival rate among the examined patients, cognitive and functional impairments of varying severity persisted during the rehabilitation phase. This fully corresponds to the "post-intensive syndrome" (PICS) described in the literature, requiring long-term monitoring and multidisciplinary rehabilitation support.

The clinical data obtained during our observation confirm that the management of patients with PRS requires not only stabilization of vital functions in the acute period, but also long-term comprehensive multidisciplinary support.

Conclusion

Postresuscitation syndrome is a complex multiorgan condition that occurs in patients after successful restoration of spontaneous circulation. Its pathogenesis is due to the interaction of hypoxic - ischemic damage, reperfusion syndrome, systemic inflammatory response, and concomitant somatic pathology.

The clinical observation conducted among patients who had suffered a cardiac arrest and were treated at the RNCM BF allowed us to confirm the multiorgan structure of the postresuscitation syndrome. Of particular importance in its formation were lesions of the central nervous system, myocardial dysfunction, infectious complications and metabolic homeostasis disorders. The results we obtained are fully consistent with modern concepts about the leading role of a multidisciplinary team in the treatment of this category of patients.

Based on the analysis of literary data and our own clinical experience, the following

practical recommendations can be identified for the management of patients with post-resuscitation syndrome:

- Early organization of a multidisciplinary team including a resuscitator, neurologist, cardiologist, endocrinologist, nutritionist, physiotherapist and psychologist.
- Implementation of targeted temperature therapy (32–36°C) for 24–48 hours for neuroprotection.
- Maintaining stable hemodynamics, optimizing cardiac function with infusion and vasopressor therapy.
- Control of ventilation and oxygenation, prevention of hypocapnia and hyperoxia.
- Cardiological examination followed by PCI in the presence of ischemic causes of circulatory arrest.
- Early nutritional support with protein and energy balance, individualization of nutrition in accordance with modern recommendations.
- Strict infection control with prevention and early treatment of hospital-acquired infections.
- Organization of early physical, cognitive and psychological rehabilitation to prevent the development of post-intensive syndrome (PICS).

Post-resuscitation syndrome remains a complex problem of modern resuscitation and intensive care, requiring further research aimed at improving neurological and functional outcomes. Only the integration of the efforts of a multidisciplinary team can ensure not just survival, but also a full return of the patient to a quality life.

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