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# Post-cardiac arrest syndrome: Epidemiology, pathophysiology, treatment, and prognostication: A Scientific Statement from the International Liaison Committee on Resuscitation; the American Heart Association Emergency Cardiovascular Care Committee; the Council on Cardiovascular Surgery and Anesthesia; the Council on Cardiopulmonary, Perioperative, and Critical Care; the Council on Clinical Cardiology; the Council on Stroke (Part 1) ☆,☆☆,☆☆☆

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☆ A Spanish translated version of the summary of this article appears as Appendix in the online version at doi:10.1016/j.resuscitation.2008.09.17.

☆☆ Endorsed by the American College of Emergency Physicians, Society for Academic Emergency Medicine, Society of Critical Care Medicine, and Neurocritical Care Society.

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**KEYWORDS**

Post-cardiac arrest syndrome;  
Therapeutic hypothermia

**Abstract**

*Aim of the review:* To review the epidemiology, pathophysiology, treatment and prognostication in relation to the post-cardiac arrest syndrome.

*Methods:* Relevant articles were identified using PubMed, EMBASE and an American Heart Association EndNote master resuscitation reference library, supplemented by hand searches of key papers. Writing groups comprising international experts were assigned to each section. Drafts of the document were circulated to all authors for comment and amendment.

*Results:* The 4 key components of post-cardiac arrest syndrome were identified as (1) post-cardiac arrest brain injury, (2) post-cardiac arrest myocardial dysfunction, (3) systemic ischaemia/reperfusion response, and (4) persistent precipitating pathology.

*Conclusions:* A growing body of knowledge suggests that the individual components of the post-cardiac arrest syndrome are potentially treatable.

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**Consensus process**

The contributors of this statement were selected to ensure expertise in all the disciplines relevant to post-cardiac arrest care. In an attempt to make this document universally applicable and generalisable, the authorship comprised clinicians and scientists who represent many specialties in many regions of the world. Several major professional groups whose practice is relevant to post-cardiac arrest care were asked and agreed to provide representative contributors. Planning and invitations took place initially by email followed a series of telephone conferences and face-to-face meetings of the co-chairs and writing group members. International writing teams were formed to generate the content of each section, corresponding to the major subheadings of the final document. Two team leaders from different countries led each writing team. Individual contributors were assigned by the writing group co-chairs to work on one or more writing team, generally reflecting their areas of expertise. Relevant articles were identified using PubMed, EMBASE and an American Heart Association EndNote master resuscitation reference library, supplemented by hand searches of key papers. Drafts of each section were written and agreed upon by the writing team authors and then sent to the co-chairs for editing and amalgamation into a single document. The first draft of the complete document was circulated among writing team leaders for initial comment and editing. A revised version of the document was circulated among all contributors and consensus was achieved before submission of the final version independent peer review and approval for publication.

**Background**

This scientific statement outlines current understanding and identifies knowledge gaps in the pathophysiology, treatment, and prognosis of patients who regain spontaneous circulation after cardiac arrest. The purpose is to provide a resource for optimizing post-cardiac arrest care and pinpointing the need for research focused on gaps in knowledge that would potentially improve outcomes of patients resuscitated from cardiac arrest.

Resumption of spontaneous circulation after prolonged complete whole-body ischaemia is an unnatural patho-physiological state created by successful cardiopulmonary resuscitation (CPR).

In the early 1970s, Dr. Vladimir Negovsky recognised that the pathology caused by complete whole-body ischaemia and reperfusion was unique in that it had a clearly definable aetiology, time course, and constellation of pathological processes (Negovsky, 1972, 1988; Negovsky and Gurvitch, 1995). Negovsky named this state *postresuscitation disease*. Although appropriate at the time, the term *resuscitation* is now used more broadly to include treatment of various shock states in which circulation has not ceased. Moreover, the term *postresuscitation* implies that the act of resuscitation has ended. Negovsky himself stated that a second, more complex phase of resuscitation begins when patients regain spontaneous circulation after cardiac arrest (Negovsky, 1972). For these reasons, we propose a new term: *post-cardiac arrest syndrome*.

The first large multicentre report on patients treated for cardiac arrest was published in 1953 (Stephenson et al., 1953). The in-hospital mortality rate for the 672 adults and children whose "heart beat was restarted" was 50%. More than a half-century later, the location, aetiology, and treatment of cardiac arrest have changed dramatically, but the overall prognosis following return of spontaneous circulation (ROSC) has not improved. The largest modern report of cardiac arrest epidemiology was published by the National Registry of CPR in 2006 (Nadkarni et al., 2006). Among the 19,819 adults and 524 children who regained any spontaneous circulation, in-hospital mortality rates were 67% and 55%, respectively. In a recent study of 24,132 patients in the United Kingdom who were admitted to critical care units after cardiac arrest, the in-hospital mortality rate was 71% (Nolan et al., 2007).

In 1966 the National Academy of Sciences-National Research Council Ad Hoc Committee on Cardiopulmonary Resuscitation published the original consensus statement on CPR (JAMA, 1996). This document described the original ABCDs of resuscitation, in which A represents airway; B, breathing; C, circulation; and D, definitive therapy. Definitive therapy includes not only the management of pathologies that cause cardiac arrest but also those that result from cardiac arrest. Post-cardiac arrest syndrome is a unique and complex combination of pathophysiological processes, including (1) post-cardiac arrest brain injury, (2) post-cardiac arrest myocardial dysfunction, and (3) systemic ischaemia/reperfusion response. This state is often complicated

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