

Available online at www.sciencedirect.com

ScienceDirect

journal homepage: <http://www.elsevier.com/locate/crvasa>

Expert consensus statement

Cardiac Arrest Centers

**Joint statement of Czech Professional Societies:
Czech Acute Cardiac Care Association of the Czech
Society of Cardiology, Czech Resuscitation Council,
Czech Society of Intensive Care Medicine ČLS JEP,
Czech Society of Anesthesiology, Resuscitation and
Intensive Care Medicine ČLS JEP, and Society for
Emergency and Disaster Medicine ČLS JEP**



Petr Ošťádal^{a,f,*}, Richard Rokyta^{a,g}, Martin Balík^{c,d,h}, Jan Bělohávek^{a,i},
Karel Cvachovec^{c,d,j}, Vladimír Černý^{c,d,k,l,m}, Pavel Dostál^{c,d,n},
Tomáš Janota^{a,b,o}, Petr Kala^{a,p}, Martin Matějovič^{c,q}, Jiří Pařenica^{a,p},
Jana Šeblová^{e,r,s}, Roman Škulec^{b,k,t,u}, Vladimír Šrámek^{c,v},
Anatolij Truhlář^{b,w,u}

^a Czech Acute Cardiac Care Association of the Czech Society of Cardiology, Czech Republic

^b Czech Resuscitation Council, Czech Republic

^c Czech Society of Intensive Care Medicine, Czech Republic

^d Czech Society of Anesthesiology, Resuscitation and Intensive Care Medicine, Czech Republic

^e Society for Emergency and Disaster Medicine, Czech Republic

^f Department of Cardiology, Complex Cardiovascular Center, Na Homolce Hospital, Czech Republic

^g Department of Cardiology, Complex Cardiovascular Center, Pilsen University Hospital and Medical School in Pilsen, Charles University, Czech Republic

^h Department of Anesthesiology, Resuscitation and Intensive Medicine, Medical School 1 of Charles University in Prague and General University Hospital, Czech Republic

ⁱ Second Department of Internal Medicine – Cardiovascular Medicine, Complex Cardiovascular Center, General University Hospital and Medical School 1 of Charles University in Prague, Czech Republic

^j Department of Anesthesiology, Resuscitation and Intensive Medicine, Charles University Medical School 2 in Prague and Motol University Hospital, Czech Republic

^k Department of Anesthesiology, Perioperative and Intensive Medicine, J. E. Purkyně University in Ústí nad Labem, Masaryk Hospital in Ústí nad Labem, Czech Republic

^l Center for Research and Development, Hradec Králové University Hospital, Czech Republic

^m Department of Anesthesiology, Resuscitation and Intensive Medicine, Charles University in Prague, Medical School in Hradec Králové, Czech Republic

* Corresponding author at: Czech Acute Cardiac Care Association of the Czech Society of Cardiology, Czech Republic.

E-mail address: ostadal.petr@gmail.com (P. Ošťádal).

<http://dx.doi.org/10.1016/j.crvasa.2017.03.009>

0010-8650/© 2017 The Czech Society of Cardiology. Published by Elsevier Sp. z o.o. All rights reserved.

¹Department of Anesthesiology, Resuscitation and Intensive Medicine, Medical School in Hradec Králové, Charles University in Prague, University Hospital in Hradec Králové, Czech Republic

²Department of Internal Medicine 3, Complex Cardiovascular Center, General University Hospital, and Medical School 1 of Charles University in Prague, Czech Republic

³Department of Internal Medicine – Cardiology, Complex Cardiovascular Center, Medical School, Masaryk University and Brno University Hospital, Czech Republic

⁴Department of Internal Medicine 1 and Biomedical Center, Medical School in Plzeň, Charles University in Prague and Plzeň University Hospital, Czech Republic

⁵Emergency Medical Service of Central Bohemian Region, Czech Republic

⁶Emergency Department, Kladno District Hospital, Czech Republic

⁷Emergency Medical Service of Central Bohemian Region in Beroun, Czech Republic

⁸Department of Anesthesiology, Resuscitation and Intensive Medicine, Medical School in Hradec Králové, Charles University in Prague and Hradec Králové University Hospital, Czech Republic

⁹Department of Anesthesiology and Resuscitation, Medical School, Masaryk University and St. Anne's University Hospital, Czech Republic

^wEmergency Medical Service of Hradec Králové Region, Hradec Králové, Czech Republic

ARTICLE INFO

Article history:

Received 1 January 2017

Received in revised form

14 March 2017

Accepted 15 March 2017

Available online 5 April 2017

Introduction

In the Czech Republic, out-of-hospital cardiac arrest (OHCA) is experienced in 60–100 patients per 100,000 population/year and ranks among the leading causes of death similarly to other developed countries [1,2]. Advances in the organization of pre-hospital emergency care have helped to improve the quality of cardiopulmonary resuscitation (CPR) through, e.g., mandatory availability of dispatcher-assisted cardiopulmonary resuscitation, introduction of so-called “first responder” activation systems with automated external defibrillators, and other measures [1,3]. Return of spontaneous circulation (ROSC) is achieved in about 40–50% patients suffering OHCA, who receive advanced cardiovascular life support, and the number of patients admitted for further post-resuscitation care in hospital wards is increasing [1,3]. Still, despite the advances in current medicine, the success rates of this therapeutic strategy remain relatively low. In the Czech Republic, less than 15% of post-resuscitation patients can usually be discharged without a major neurological deficit to receive home care [2].

The body of literature-based evidence regarding individual therapeutic strategies employed in post-resuscitation care remains absolutely inadequate. Of the commonly used therapeutic options, only maintaining body temperature at 33 °C or 36 °C has been relatively reliably shown to improve

prognosis [4–6]. However, despite the lack of data from large prospective studies, there has been recently consensus (particularly based on retrospective studies) that a number of out-of-hospital cardiac arrest survivors do benefit from specialized care including diagnostic and therapeutic strategies currently available only in major healthcare facilities [7–16]. This is the reason behind the recently launched initiative to create specialized Cardiac Arrest Centers (Cardiac Arrest Receiving Centers) to admit cardiac arrest survivors and provide comprehensive dedicated post-resuscitation care [17–26]. The Czech Republic is no exception in this respect and it is most likely that improving of the logistics of care for cardiac arrest survivors may help improve the outcomes of these patients.

Definition of the Cardiac Arrest Center

Each such facility should have an adequate number of resuscitation care beds available to admit cardiac arrest patients as well as qualified medical and paramedical staff trained in diagnostic and therapeutic modalities and decision-making processes to be applied in this patient population. The following procedures/techniques should be available and feasible on a round-the-clock, 24/7 basis:

- Diagnostic workup using the necessary imaging techniques (primarily echocardiography, ultrasound, and CT);
- Coronary angiography and percutaneous coronary intervention;
- Temporary cardiac pacing;
- Pericardiocentesis;
- Targeted temperature management keeping body temperature at 33 °C or 36 °C;
- Comprehensive resuscitation and post-resuscitation care;
- While extracorporeal CPR (ECPR) may be an advantage, it is not obligatory given the small body of current evidence.

Depending on the cause of sudden circulatory arrest, other findings in each individual patient, and current availability, the respective resuscitation bed may be part of cardiac intensive care units (CICUs), departments of anesthesiology

and resuscitation/intensive care medicine, and/or other specialized, and multidisciplinary critical care units.

Organization of pre-hospital care

Unless the patient has an obvious non-cardiac cause of out-of-hospital circulatory arrest (asphyxia, injury, etc.) and has no known disease justifying non-provision of further resuscitation care (e.g., end-stage chronic disease), the mobile Emergency Medical Service (EMS) team should contact a Cardiac Arrest Center (CAC). In cases where there are no objective reasons for adopting a different strategy, the patient should be – after recorded online/phone consultation between the Center's and EMS physicians – transported primarily to CAC right from the field. Post-resuscitation patients with ST-segment elevation (STEMI) documented by 12-lead ECG should be preferentially transported directly to the cardiac catheterization lab without being admitted through the emergency department or ward of the receiving hospital (so called “fast track concept”).

In patients suffering OHCA refractory to initial steps in the algorithm of advanced life support (particularly defibrillation shocks) while meeting favorable prognostic criteria (cardiac arrest occurring in the presence of a mobile EMS team or bystanders, resuscitation initiated by lay or professional rescuers without delay, initially shockable rhythm or likely reversible cause of cardiac arrest or intermittent ROSC), it is advised to consider transfer of the patient to CAC while continuing to use mechanical CPR [27]. The decision to transport the patient should be made in the early phase of resuscitation, ideally within 10 min of initiating advanced life support (i.e., after the third defibrillation shock at the latest) [28]. A prerequisite for this is a pre-defined algorithm of well-coordinated pre-hospital and in-hospital care including the possibility to immediately transfer the patient to a catheterization lab, availability of teams experienced in mechanical CPR and percutaneous coronary intervention during continuous CPR. However, given the current level of evidence, this strategy should not be applied on a routine basis [27].

Procedures in the Cardiac Arrest Center

All patients admitted to hospital following an out-of-hospital cardiac arrest should have baseline assessment in the Emergency Department or other resuscitation bed of the receiving facility (except for STEMI patients transported preferentially directly to the catheterization lab). The aim of this strategy is to identify – based on rapidly available data – the cause of cardiac arrest, assess prognostic markers and, possibly, initiate causal therapy. Other necessary steps, in addition to assessment of available medical history data, include physical examination, ECG (evaluated by a cardiologist), bedside echocardiography, and chest ultrasound, quick assessment of the internal milieu (blood gases, kalemia, hemoglobin/hematocrit, lactate) or, possibly, brain CT. It is in this particular stage that blood samples should also be obtained from all patients for further basic laboratory tests.

In cases where the cause of cardiac arrest has been identified, it is critical to proceed according to the established diagnosis (e.g., STEMI or, most likely, non-ST-segment elevation acute coronary syndrome, cardiac tamponade, pulmonary embolism, hyperkalemia, bradycardia, intracranial hemorrhage). In patients experiencing a cardiac arrest of unclear etiology while an acute coronary syndrome cannot be ruled out and no markedly adverse prognostic factors are present (e.g., unwitnessed cardiac arrest, long time to resuscitation initiation, initial asystole, high lactate levels), urgent coronary angiography should always be considered. As coronary artery obstruction is a frequent cause of cardiac arrest even in this patient subpopulation, coronary intervention may improve their prognosis. Patients in whom the cause of cardiac arrest continues to be unclear can be considered for head and chest CT. Head and cervical spine CT should also be considered in all patients with a history of fall. Monitoring of body core temperature should be started without any delay and achieving and maintaining the target temperature of 33 °C or, alternatively, 36 °C is mandatory as soon as possible.

The patient is subsequently admitted to a resuscitation bed of a CICU, department of anesthesiology and resuscitation, or, possibly, another specialized or multidisciplinary ICU capable of providing comprehensive resuscitation and post-resuscitation care. The Cardiac Arrest Center should also provide further specialized care (e.g., neuroprognostification, cardioverter-defibrillator implantation, post-cardiac arrest psychological care etc.) or determine further strategy of individualized patient care.

Given the need for providing further specialized post-resuscitation care and the Center's limited bed capacity, the patient may alternatively be transferred to a regional medical center to receive subsequent care (intensive, internal, neurologic, rehabilitation, etc.).

Aims of creating Cardiac Arrest Centers

The aim of the initiative is to create a Czech nationwide network of Cardiac Arrest Centers designed to provide current evidence-based comprehensive care of cardiac arrest survivors. Except for cases specified above, these centers should admit all adults experiencing out-of-hospital cardiac arrest of suspected cardiac etiology.

Preconditions for creating a Cardiac Arrest Center

With respect to the above specified requirements for round-the-clock availability of diagnostic and therapeutic procedures in specialized centers, a nationwide network of such centers could be based to some extent on the cardiovascular centers (i.e., those providing highly specialized complex cardiovascular care and those providing highly specialized cardiovascular care) whose contribution to care of cardiac arrest survivors is absolutely critical. Medical centers becoming Cardiac Arrest Centers should provide active interdisciplinary cooperation involving cardiologists, emergency physicians, anesthesiologists, intensivists, neurologists, radiologists, and other specialists. A *conditio sine qua non*

is an adequate number of resuscitation beds to accommodate emergency admissions of cardiac arrest survivors who may benefit from specialized care. Other important aspects include logistics of transport of patients who no longer require care in the Center to regional inpatient facilities so as to vacate beds for other emergency patients experiencing cardiac arrest as well as close cooperation with the EMS provider in the respective region.

REFERENCES

- [1] G.D. Perkins, A.J. Handley, R.W. Koster, et al., European Resuscitation Council Guidelines for Resuscitation 2015: Section 2. Adult basic life support and automated external defibrillation, *Resuscitation* 95 (2015) 81–99, PMID: 26477420.
- [2] J.T. Gräsner, R. Lefering, R.W. Kostner, et al., EuReCa ONE – 27 Nations, ONE Europe, ONE Registry. A prospective one month analysis of out-of-hospital cardiac arrest outcomes in 27 countries in Europe, *Resuscitation* 105 (2016) 188–195.
- [3] J. Soar, J.P. Nolan, B.W. Bottiger, et al., European Resuscitation Council Guidelines for Resuscitation 2015: Section 3. Adult advanced life support, *Resuscitation* 95 (2015) 100–147.
- [4] HACA-Study-Group, Mild therapeutic hypothermia to improve the neurologic outcome after cardiac arrest, *New England Journal of Medicine* 346 (2002) 549–556.
- [5] S.A. Bernard, T.W. Gray, M.D. Buist, et al., Treatment of comatose survivors of out-of-hospital cardiac arrest with induced hypothermia, *New England Journal of Medicine* 346 (2002) 557–563.
- [6] N. Nielsen, J. Wetterslev, T. Cronberg, et al., Targeted temperature management at 33 degrees C versus 36 degrees C after cardiac arrest, *New England Journal of Medicine* 369 (2013) 2197–2206.
- [7] H. Soholm, K. Wachtell, S.L. Nielsen, et al., Tertiary centres have improved survival compared to other hospitals in the Copenhagen area after out-of-hospital cardiac arrest, *Resuscitation* 84 (2013) 162–167.
- [8] G. Xiao, Q. Guo, M. Shu, et al., Safety profile and outcome of mild therapeutic hypothermia in patients following cardiac arrest: systematic review and meta-analysis, *Emergency Medicine Journal* 30 (2013) 91–100.
- [9] M.J. Kang, T.R. Lee, T.G. Shin, et al., Survival and neurologic outcomes of out-of-hospital cardiac arrest patients who were transferred after return of spontaneous circulation for integrated post-cardiac arrest syndrome care: the another feasibility of the cardiac arrest center, *Journal of Korean Medical Science* 29 (2014) 1301–1307.
- [10] D.W. Spaite, B.J. Bobrow, U. Stolz, et al., Statewide regionalization of postarrest care for out-of-hospital cardiac arrest: association with survival and neurologic outcome, *Annals of Emergency Medicine* 64 (2014) 496–506, e1.
- [11] B.G. Carr, M. Goyal, R.A. Band, et al., A national analysis of the relationship between hospital factors and post-cardiac arrest mortality, *Intensive Care Medicine* 35 (2009) 505–511.
- [12] B.G. Carr, J.M. Kahn, R.M. Merchant, et al., Inter-hospital variability in post-cardiac arrest mortality, *Resuscitation* 80 (2009) 30–34.
- [13] C.W. Callaway, R. Schmicker, M. Kampmeyer, et al., Receiving hospital characteristics associated with survival after out-of-hospital cardiac arrest, *Resuscitation* 81 (2010) 524–529.
- [14] C.W. Callaway, R.H. Schmicker, S.P. Brown, et al., Early coronary angiography and induced hypothermia are associated with survival and functional recovery after out-of-hospital cardiac arrest, *Resuscitation* 85 (2014) 657–663.
- [15] I. Lund-Kordahl, T.M. Olasveengen, T. Lorem, et al., Improving outcome after out-of-hospital cardiac arrest by strengthening weak links of the local Chain of Survival; quality of advanced life support and post-resuscitation care, *Resuscitation* 81 (2010) 422–426.
- [16] D. Stub, K. Smith, J.E. Bray, et al., Hospital characteristics are associated with patient outcomes following out-of-hospital cardiac arrest, *Heart* 97 (2011) 1489–1494.
- [17] B.J. Bobrow, T.F. Vadeboncoeur, L. Clark, V. Chikani, Establishing Arizona's statewide cardiac arrest reporting and educational network, *Prehospital Emergency Care: Official Journal of the National Association of EMS Physicians and the National Association of State EMS Directors* 12 (2008) 381–387.
- [18] C. Martin-Gill, C.P. Dilger, F.X. Guyette, et al., Regional impact of cardiac arrest center criteria on out-of-hospital transportation practices, *Prehospital Emergency Care: Official Journal of the National Association of EMS Physicians and the National Association of State EMS Directors* 15 (2011) 381–387.
- [19] D.P. Davis, R. Fisher, S. Aguilar, et al., The feasibility of a regional cardiac arrest receiving system, *Resuscitation* 74 (2007) 44–51.
- [20] A.C. Heffner, D.A. Pearson, M.L. Nussbaum, A.E. Jones, Regionalization of post-cardiac arrest care: implementation of a cardiac resuscitation center, *American Heart Journal* 164 (2012) 493–501, e2.
- [21] M.W. Donnino, J.C. Rittenberger, D. Gaieski, et al., The development and implementation of cardiac arrest centers, *Resuscitation* 82 (2011) 974–978.
- [22] G. Nichol, T.P. Aufderheide, B. Eigel, et al., Regional systems of care for out-of-hospital cardiac arrest: a policy statement from the American Heart Association, *Circulation* 121 (2010) 709–729.
- [23] G. Nichol, J. Soar, Regional cardiac resuscitation systems of care, *Current Opinion in Critical Care* 16 (2010) 223–230.
- [24] J. Soar, S. Packham, Cardiac arrest centres make sense, *Resuscitation* 81 (2010) 507–508.
- [25] J.P. Nolan, J. Soar, A. Cariou, et al., European Resuscitation Council and European Society of Intensive Care Medicine Guidelines for Post-resuscitation Care 2015: Section 5 of the European Resuscitation Council Guidelines for Resuscitation 2015, *Resuscitation* 95 (2015) 202–222.
- [26] S.G. Priori, C. Blomstrom-Lundqvist, A. Mazzanti, et al., 2015 ESC Guidelines for the management of patients with ventricular arrhythmias and the prevention of sudden cardiac death: The Task Force for the Management of Patients with Ventricular Arrhythmias and the Prevention of Sudden Cardiac Death of the European Society of Cardiology (ESC) Endorsed by: Association for European Paediatric and Congenital Cardiology (AEPC), *European Heart Journal* 36 (2015) 2793–2867.
- [27] A. Truhlar, C.D. Deakin, J. Soar, et al., European Resuscitation Council Guidelines for Resuscitation 2015: Section 4. Cardiac arrest in special circumstances, *Resuscitation* 95 (2015) 148–201.
- [28] L.L. Bossaert, G.D. Perkins, H. Askitopoulou, et al., European Resuscitation Council Guidelines for Resuscitation 2015: Section 11. The ethics of resuscitation and end-of-life decisions, *Resuscitation* 95 (2015) 302–311.