Treatment and outcome of patients after cardiopulmonary resuscitation admitted to the intensive cardiac care unit

Vratislav Pechman, Richard Rokyta, Petr Gajdos, Jan Pesek

Intensive Cardiac Care Unit, Department of Medicine I, University Hospital Plzen and Faculty of Medicine Plzen, Charles University Prague.

Correspondence to: Assoc. prof. Richard Rokyta, M.D., PhD
Intensive Cardiac Care Unit, Department of Medicine I
Alej Svobody 13, 323 00 Plzeň, Czech Republic.
PHONE: +420 377103120; FAX: +420 377103163; E-MAIL: rokyta@fnplzen.cz

Submitted: 2009-05-08 Accepted: 2009-05-27 Published online: 2009-09-13

Key words: **circulatory arrest; cardiopulmonary resuscitation; post-resuscitation care; mild hypothermia; acute coronary syndrome; intensive care; percutaneous coronary intervention**

Neuroendocrinol Lett 2009; **30**(3): 363–367 **PMID:** 19855360 NEL300309A05 © 2009 Neuroendocrinology Letters • **www.nel.edu**

Abstract

OBJECTIVES: Sudden circulatory arrest is most often of cardiac origin. Our aim was to evaluate circulatory arrest etiology and treatment strategies in patients after cardiopulmonary resuscitation (CPR) with persistent impairment of consciousness in relation to survival and the subsequent quality of life.
DESIGN: Retrospective analysis of patients after CPR treated according to the local protocol including mild hypothermia in the intensive cardiac care unit.
RESULTS: Over 2 years, we admitted 57 mechanically ventilated patients after CPR. 47 patients (82%) were resuscitated outside the hospital. In 33 patients (58%) the initial rhythm was ventricular fibrillation; in the remaining patients (42%) asystole/pulseless electrical activity. Urgent coronary angiography was performed in 36 patients and percutaneous coronary intervention in 25 of them. The admission APACHE II score was 32,4 ± 3,4 with predicted mortality of 77,1%. The hospital survival rate was 54% and 47% of the patients were discharged home in a good state of health (Glasgow outcome score 4–5).
CONCLUSION: Our results suggest that comprehensive post-resuscitation care including therapeutic hypothermia and percutaneous coronary intervention in selected cases may have a positive impact on the prognosis of patients after CPR.

INTRODUCTION

Sudden circulatory arrest outside the hospital is the most common cause of adult mortality in developed countries (15–20% of all causes of death), affecting approximately 1 in 1,000 people every year (Priori *et al.* 2002). Contrary to the detailed cardiopulmonary resuscitation (CPR) standards (Nolan *et al.* 2005), recommendations for patient care in the post-resuscitation period are scarce, due to lack of relevant human data. Since the cause of sudden circulatory arrest in adults has a high probability of cardiac origin (80%) and most often represents the first sign of ischemic heart disease (IHD) as well (unstable plaque with coronary thrombosis), some patients are hospitalized in intensive care units with cardiac specialization. Patients after CPR have in general a very unfavourable prognosis with frequent neurological deficit and according to various authors, only 19–46% of them are discharged home in a satisfactory health condition (Hypothermia after Cardiac Arrest Study Group 2002, Granja *et al.* 2002, Bunch *et al.* 2003).

ORIGINAL ARTICLE

Abbreviations:

ACS:	– acute coronary syndrome
APACHE:	– acute physiology and chronic health evaluation
AV:	– atrioventricular
CAG:	– coronary angiography
CPR:	– cardiopulmonary resuscitation
ECG:	– electrocardiogram
GOS:	– Glasgow outcome score
ICCU:	– intensive cardiac care unit
IHD:	– ischemic heart disease
LQT:	– long QT interval
MAP:	– mean arterial pressure
$PaCO_2$:	– partial pressure of carbon dioxide
PCI:	– percutaneous coronary intervention
PEA:	– pulseless electrical activity
STEMI:	– ST-elevation myocardial infarction
VF:	– ventricular fibrillation
VT:	– ventricular tachycardia

Our aim was to evaluate the medical history data and treatment of a patient group hospitalized after CPR in our Intensive Cardiac Care Unit (ICCU) in relation to their survival and subsequent quality of life.

MATERIALS AND METHODS

We analyzed retrospectively the data of adult patients who had been admitted to the ICCU after CPR due to circulatory arrest with persistent consciousness impairment upon ICU admission. The data analysis included the APACHE II score on admission and inferring predicted mortality (Knaus *et al.* 1985). All patients were assessed by a cardiologist before their admission to ICCU. If acute coronary syndrome was highly suspected as the cause of circulatory arrest, an urgent coronary angiography (CAG) investigation was performed after essential short-term patient stabilization. The indications for immediate CAG were as follows: ST segment elevations/deep depressions on the ECG or bundle branch block or localized wall motion abnormalities on echocardiography or history of chest pain.

Patients were treated according to the local protocol for post-resuscitation care with special emphasis on early therapeutic hypothermia induction (target temperature 32–34 °C applied for a period of 24 hours), normoventilation (optimal $PaCO_2$ 4–4,7 kPa), invasive mean arterial pressure monitoring (goal 80–100 mmHg), glycemia monitoring and treatment (target 5–8 mmol/l) and electrolyte monitoring (optimal sodium levels 140–150mmol/l, potassium levels 4,5–5mmol/l). To cool the patient, we combined intravenous cooling with crystalloid fluids (Plasma-lyte, Baxter) given at a temperature of +4 °C (initial bolus of 30ml/kg, speed up to 100 ml/min depending on the hemodynamic status) and external cooling. During the hypothermia induction, the patients were sedated and relaxed to prevent shivering thermogenesis. The contraindications for therapeutic hypothermia were defined as follows: decreased category of treatment (withhold or withdraw therapy), excessive bleeding including intracranial hemorrhage and severe hemodynamic instability. We considered a reduction of the hypothermic period to 12 hours in patients with a high risk of infection (e.g. excessive aspiration). The end of the hypothermic phase was followed by slow, spontaneous rewarming (0.25–0.5 °C/hour) and prevention of hyperthermia during the next 24 hours.

We monitored our patients until the end of hospitalization, when the Glasgow outcome score (GOS) upon discharge was assessed (***Table 1***). A patient discharged home in a good clinical condition corresponding to GOS values of 4–5 was considered success of our treatment.

RESULTS

From the beginning of January 2005 until the end of December 2006, we admitted in total 57 adult patients (age 66 ± 12 years, male/female 44/13) after CPR with persistent consciousness impairment to our ICCU. The APACHE II score on admission was 32,4 ± 3,4 with predicted mortality of 77.1%. The ICCU mortality within our patient group was 35% and the total hospital mortality was 46%. The etiology of circulatory arrest is shown in ***Table 2***.

Circulatory arrest occurred in 47 (82%) cases outside the hospital while 10 (18%) patients experienced sudden circulatory arrest in a hospital environment. The first detected heart rhythm was ventricular fibrillation/tachycardia in 33 patients (58%) and asystole or pulseless electrical activity in 24 (42%) patients. The clinical outcome of patients in relation to the location of circulatory arrest and to the first detected rhythm is summarized in ***Figure 1***.

The indications and results of coronary angiography investigations are summarized in ***Table 3***.

All that patients were planned to cool to a final temperature of 32–34 °C for a period of 24 hours. The target temperature was reached in 37 patients (65%). Within

Table 1. Glasgow outcome score (GOS)

GOS 5	Good condition	Return to normal life, with insignificant deficit of physiological functions
GOS 4	Mild impairment	Neurological deficit, but self-sufficient. Able to work in special conditions.
GOS 3	Severe impairment	Conscious, but not self-sufficient. Dependent on the help of others.
GOS 2	Persistent vegetative state	Unconsciousness, coma vigile
GOS 1	Death	Died

Copyright © 2009 Neuroendocrinology Letters ISSN 0172–780X • www.nel.edu

the group of patients who had reached the final temperature, 57% of them were discharged home in satisfactory clinical condition (GOS 4–5). Within the group where the final temperature was not reached, only 35% of the patients were discharged in satisfactory condition. However, this difference did not achieve statistical significance (p=NS).

Out of 57 patients hospitalized in our ICCU after CPR, 27 (47%) were discharged home in good health condition (GOS 4–5). 10 of them were discharged home from non-ICU wards of our hospital, 8 patients were discharged home from regional hospitals where they had been transferred from our ICCU, and 9 patients were discharged home after implantable cardioverter defibrillator implantation in other cardiac centres.

In total, 26 (46%) patients died – 20 in our ICCU, 6 after transfer to a non-ICU ward in our hospital. Four (7%) patients with GOS 2–3 were transferred to wards with assistant care.

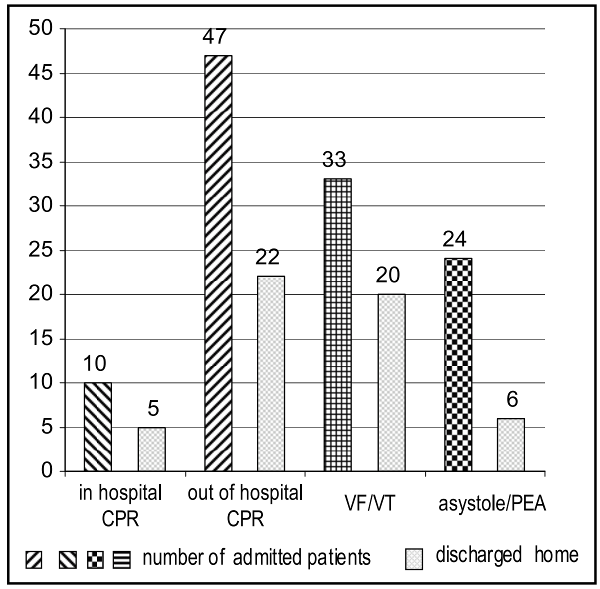

Figure 1. Clinical outcome of patients by location of circulatory arrest and by 1st detected heart rhythm. CPR = Cardiopulmonary Resuscitation, VF = Ventricular Fibrillation, VT = Ventricular Tachycardia, PEA = Pulseless Electrical Activity

DISCUSSION

Circulatory arrest in adults is of cardiac origin in 75–80% of all cases (Kim *et al.* 2001, Fries *et al.* 2007). A frequent condition leading to sudden circulatory arrest is acute myocardial infarction. This disease was also found to be the most frequent in our patient group when analyzed by main clinical diagnoses. The first registered ECG performed on-site showed that in our dataset ventricular tachycardia/fibrillation (VT/VF) prevailed over asystole/pulseless electrical activity (PEA). This was very likely caused by the greater probability of return of spontaneous circulation at the time of CPR and subsequent transport of patients with defibrillated heart rhythm (VT/VF) to our hospital. Our results confirmed, in accordance with other published data, the better clinical outcome of patients with defibrillated heart rhythm when compared to patients with the first detected rhythm asystole/PEA (Kim *et*

Table 2 Etiology of circulatory arrest

Cause of circulatory arrest	Number of patients
Acute myocardial infarction	27 (47%)
Malignant arrhythmia in patients with severe left ventricular systolic dysfunction	16 (28%)
Severe electrolyte imbalance	5 (9%)
AV block IIIrd degree. /LQT syndrome	4 (7%)
Other	5 (9%)
Total	57

AV = Atrioventricular, LQT = Long QT

Table 3. Indications of coronary angiography

Indication	Number of patients
ST segment elevations/BBB on ECG	29
ST segment depressions on ECG	4
Localized left ventricular wall motion abnormalities/ history of angina pectoris	3
Total	36
Ratio coronary angiography/immediate PCI	36/25

BBB = bundle branch block, ECG = electrocardiogram, PCI = percutaneous coronary intervention *al.* 2001, Fries *et al.* 2007). In our study, the outcome of the patients resuscitated in hospital did not differ significantly from the outcome of the patients resuscitated outside a hospital. This observation could be biased by the relatively small number of patients in the former group.

The mortality of patients treated after CPR due to circulatory arrest is high overall (Hypothermia after Cardiac Arrest Study Group (2002), Granja *et al.* 2002, Bunch *et al.* 2003). To improve the trend, we need not only to carry out early and adequate CPR, but also to perform rapid diagnostics and treatment of reversible causes of circulatory arrest. When early and adequate treatment is provided, patients suffering circulatory arrest of cardiac origin have a greater chance of survival (Kim *et al.* 2001, Fries *et al.* 2007) and therefore, our patients after CPR were all assessed by a cardiologist as soon as possible after their admission to the hospital. Patients with a high suspicion of acute coronary syndrome (ACS) were indicated for coronary angiography immediately after initial short-term stabilization. The coronary angiography investigation (PCI) and subsequent PCI may play a significant role in circulatory stabilization in ACS patients. Without hemodynamic stabilization it is impossible to achieve optimal organ perfusion (including the brain) and to reduce their organs' hypoxic-reperfusion alterations. The study by Werlin et al. demonstrated that successful PCI after resuscitated cardiac arrest was a multivariate predictor of hospital survival (Werlin *et al.* 2007).

To ensure sufficient organ perfusion, it is necessary to optimize the mean arterial pressure (MAP). Usually, the target MAP value is recommended as "normal or slightly increased" (80–100mm Hg) in particular to ensure adequate cerebral perfusion pressure, this was also our strategy (Nolan *et al.* 2005). The application of catecholamines (dobutamin/levosimendan and/or norepinephrine in our unit) is usually necessary after preload optimization even in patients with ACS and early revascularization (PCI) (Rokyta & Pechman 2006). Nevertheless, further studies are needed since long-term catecholamine administration in order to achieve higher MAP levels may lead to afterload increase, which in turn might compromise the myocardial energetic metabolism and performance.

Our local guidelines for the treatment of patients after CPR are focused particularly on the application of therapeutic hypothermia, which, according to many studies, reduces post hypoxic-reperfusion brain damage in patients after CPR (Nolan *et al.* 2005, Hypothermia after Cardiac Arrest Study Group 2002, Langhelle *et al.* 2003, Bernard *et al.* 2002, Lukaskova et al. 2008). Moreover, recent published 3 single center small studies (together 106 patients) have shown feasibility and safety of combining primary PCI and mild therapeutic hypothermia in comatose survivors of ventricular fibrillation due to STEMI (Knafelj *et al.* 2007, Wolfrum *et al.* 2008, Hovdenes *et al.* 2007). Moreover, these studies found much better clinical outcome in these selected STEMI patients´groups (Noc & Radseel 2008).

All patients in our study group were found to be eligible for therapeutic hypothermia. The main reasons for not reaching the desired temperature were the development of significant hemodynamic instability or severe arrhythmias, resulting in interruption of the process of cooling. Patients who had reached the desired temperature had a better clinical outcome. However, we were unable to interpret this finding clearly because of the retrospective design of our study.

Comprehensive post-resuscitation treatment further includes adequate monitoring and correction of glycemia. Hyperglycemia is associated with a worse neurological impairment of patients after CPR and does increase the mortality of critically ill patients (Nolan *et al.* 2005, Langhelle *et al.* 2003). Although the optimal glycemia has yet to be determined in critically ill patients, we corrected its levels to 5–8 mmol/l, which was in agreement with the recommendations of the Surviving Sepsis campaign (Dellinger & Vincent 2005).

Our study has some limitations. It was a retrospective study. Patients admitted to the ICCU were usually selected a priori in the emergency room and about half of them presented acute myocardial infarction. Despite a non-randomized design, our data suggest that patients with cardiac arrest can benefit from implemented comprehensive post-resuscitation diagnostic and treatment algorithms and guidelines and that their long-term clinical outcome can be improved. Further studies are needed to confirm the potential benefit of urgent coronary angiography/PCI in certain patient subgroups (e.g. CPR and acute coronary syndrome without ST segment elevations).

Statistics

Fischer exact test was used. $p<0.05$ was considered statistical significant**.**

CONCLUSION

Patients after cardiopulmonary resuscitation with persistent loss of consciousness treated in our intensive cardiac care unit achieved a substantially better clinical outcome as compared to published data. Our patients had experienced circulatory arrest, mostly of cardiac origin. Our results suggest that the otherwise very unfavourable prognosis of these patients may be improved by applying a comprehensive post-resuscitation protocol, including early coronary angiography/percutaneous coronary intervention in indicated cases and the use of therapeutic hypothermia.

Ackowledgement

This paper was supported by the Charles University, Prague Research Project No. MSM 0021620817 awarded by the Ministry of Education, Youth and Sports of the Czech Republic.

Copyright © 2009 Neuroendocrinology Letters ISSN 0172–780X • **www.nel.edu**

REFERENCES

1 Bernard SA, Gray TW, Buist MD, Jones BM, Silvester W, Gutteridge G et al (2002). Treatment of comatose survivors of out-of-hospital cardiac arrest with induced hypothermia. N Engl J Med. **346**: 557–563.
2 2. Bunch T.J, White R.D, Gersh B.J, Meverden R.A, Hodge D.O, Ballman K.V et.al. (2003). Long-Term Outcomes of Out-of-Hospital Cardiac Arrest after Successful Early Defibrillation. N Engl J Med. **348**: 2626–2633.
3 Dellinger RP, Vincent J.L. (2005). The Surviving Sepsis Campaign sepsis care bundles and clinical practice. Crit Care. 9: 653–654.
4 Fries M, Beckers S, Bickenbach J, Skorning M, Krug S, Nilson E et al. (2007). Incidence of cross-border emergency care and outcomes of cardiopulmonary resuscitation in a unique European region. Resuscitation.**72**: 66–73.
5 Granja C, Cabral G, Pinto AT, Costa-Pereira A (2002). Quality of life 6-months after cardiac arrest. Resuscitation. **55**: 37– 44.
6 6. Hovdenes J, Laake JH, Aaberge L, Haugaa H, Bugge JF (2007). Therapeutic hypothermia after out-of-hospital cardiac arrest: experiences with patients treated with percutanous coronary intervention and cardiogenic shock. Acta Anaesth Scand. **51**: 137–142.
7 Hypothermia after Cardiac Arrest Study Group (2002). Mild therapeutic hypothermia to improve the neurologic outcome after cardiac arrest. N Engl J Med. **346**: 549–556.
8 Kim C, Fahrenbruch CE, Cobb LA, Eisenberg MS (2001). Out-of-Hospital Cardiac Arrest in Men and Women. Circulation. 104: 2699–2703.
9 Knafejl R, Radsel P, Ploj T, Noc M (2007). Primary percutaneous coronary intervention and mild induced hypothermia in comatose survivors of ventricular fibrillation with ST-elevation acute myocardial infarction. Resuscitation. **74**: 227–234.
10 Knaus WA, Draper EA, Wagner DP, Zimmerman JE (1985). APACHE II: a severity of disease classification system. Crit Care Med. **13**: 818–29.
11 Langhelle A, Tyvold SS, Lexow K, Napnes SA, Sunde K, Steen PA (2003) In-hospital factors associated with improved outcome after out-of-hospital cardiac arrest. A comparsion betwen four regions in Norway. Resuscitation. **56**: 247–263.
12 Lukaskova J, Tomsikova Z, Kokstein Z (2008). Cerebral function monitoring in neonates with perinatal asphyxia-preliminary results. Neuroendocrinol Lett. **29**: 522–528.
13 Nolan JP, Deakin CHD, Soar J, Bottiger BW, Smith G (2005). European Resuscitation Council. Guidelines for Resuscitation 2005 Section 4. Adult advanced life support. Resuscitation. **67:** Suppl 1, S39–S86.
14 Noc M, Radsel P (2008). Urgent invasive coronary strategy in patients with sudden cardiac arrest. Curr Opin in Crit Care. **14**: 287–291.
15 Priori SG, Aliot E, Blomstrom–Lundqvist C, Bossaert L, Breithardt G Brugada P et al. Task Force on Sudden Cardiac Death. European Society of Cardiology. Europace. **4**:3–18.
16 Rokyta R jr, Pechman V. (2006) The effects of levosimendan on global haemodynamics in patients with cardiogenic shock. Neuroendocrinol Lett **27**: 121–127.
17 Van den Berghe G, Wouters P, Weekers F, Verwaest Ch, Bruyninckx F, Schetz M et al. (2001). Intensive Insulin Therapy in Critically Ill Patiens. N Engl J Med. **345**:1359–1367.
18 Werling M, Thoren AB, Axelsson C, Herlitz J. (2007) Treatment and outcome in post-resuscitation care after out-of-hospital cardiac arrest when a modern therapeutic approach was introduced. Resuscitation **73**: 40–5.
19 Wolfrum S, Pierau CH, Radke PW Schunkert H, Kurowski V (2008). Mild therapeutic hypothermia in patients after out-of-hospital cardiac arrest due to acute ST-segment elevation myocardial infarction undergoing immediate percutaneous coronary intervention. Crit Care Med. **36**: 1780–1786.