Neurological Prognosis after Cardiopulmonary Resuscitation

Instead of great advances in the field of emergency- and intensive care medicine during the last three decades, patients successfully resuscitated from cardiac arrest (CA) are at high risk of increased mortality and their longterm outcome is often complicated by developing severe neurological disorders up to a persistent vegetative state. Today CA is the third leading cause of coma, second only to trauma and drug overdose[1]. Although numerous studies concerning prognosis after CA and cardiopulmonary resuscitation (CPR) have been performed, a great degree of uncertainty still exists.

Prognostic Parameters of Cerebral Hypoxia after Cardiac Arrest

Patient-dependent and resuscitation-dependent factors

Patient-dependent factors are preexistent medical conditions such as intrinsic heart disease, the presenting cardiac rhythm, asystole and electromechanical dissociation indicating an unfavorable outcome[2]. Mean arterial blood pressure during the first two hours after CA, but not hypertensive reperfusion within the first minutes after return of spontaneous circulation, is positively associated with outcome[3].

Resuscitation-dependent factors are witnessed versus unwitnessed arrest, bystander-initiated CPR[1], effects of early defibrillation[4], the duration of anoxia and the duration of CPR[5,6].

Postanoxic coma

The duration of postanoxic coma is an important indicator of outcome. Bell and Hodgson[7] stated that full recovery from coma of more than three days duration is exceptional and several observers have noted that persistence of unresponsive coma for 48 hours after CA was predictive of poor outcome[1,8]. Only 12% of patients being comatose more than six hours after CA survive with a good neurologic outcome or moderate neurologic deficits[9].

Clinical neurologic signs

Pupillary reaction to light has been shown to be the most predictive parameter of outcome[1,9,10,11] with the least interobserver variability[1]. Further clinical neurologic signs with comparable outcome-predictive power are motor response to noxious stimuli[1,9,10] and brain-stem reflexes[1,4,9] especially when they are lacking on the third day after CA.

Coma Scales

The prognostic importance of the Glasgow Coma Score (GCS) has been demonstrated by various investigators[1,10,11]. A best GCS of more than 9 points or of less than 5 points up to day 2 after CA was highly predictive of good and poor outcome, respectively. The predictive value of the Innsbruck Coma Scale (ICS) could be shown as well[6]. Coma rating performed at the time of arrival of rhe emergency team on the scene was not, whereas coma rating performed 20 to 30 minutes later was statistically significant for outcome. All patients with 0 and 1 point on the ICS died, whereas all patients with more than 5 points survived with favorable outcomes.

Prognostic Scoring Systems

The Longstreth Awakening Score[12] and the Grubb Prognostic Scoring System[2] combine neurologic and medical points of view. The Longstreth Awakening Score is based on motor response, pupillary light reflex, spontaneous eye movements, and admission blood glucose. The Grubb Prognostic Scoring System includes presenting rhythm other than ventricular fibrillation, resuscitation by a non-health professional, and the GCS.

Laboratory Parameters

Both elevated serum glucose and lactate levels in the postresuscitation period have been shown to be prognostic signs[1]. Apart from these parameters the concentration of neuron-specific enolase and protein S-100 in serum can be used for outcome prediction in patients with hypoxic brain damage[4,13,14], especially when being measured 3 to 5 days after CA. Investigations of the cerebrospinal fluid have demonstrated the prognostic significance of lactate and adenylate kinase activity, of creatine kinase and neural adhesion molecules,of neuron-specific enolase, of monoamines, monoamine metabolites, myelin basic protein, and of astroglial protein[1,4].

Intracranial and Cerebral Perfusion Pressures

A neurologic worsening is sometimes associated with an increase of intracranial pressure. The prognostic impact of early increased intracranial pressures and decreased cerebral perfusion pressures was demonstrated by Gueugniaud et al[15] in 84 patients with deep anoxic coma after CA.

Electrophysiologic Predictors

EEG abnormalities are usually classified into five

Dr K Berek

Dr M.Mayr

Corespondence Address:
Neurological Department,
Aö.-BKH-Kufstein, Austria
Email. klaus.berek@
bkh-kufstein.at

Table 1: Clinical parameters after CPR

Clinical parameters	Unfavorable prognosis
Duration of anoxia	>8-10 min [5]
Duration of CPR	>30 min [5]
Duration of postanoxic coma	>72 h [10]
Pupillary light reaction	Absent on day 3 [10]
Motor response to pain	Absent on day 3 [9,10]
Brainstem reflexes	Absent on day 3 [10]
Blood glucose	On admission >300mg/dl [12]
ICS	20-30 min after inition of CPR <4 [6]
GCS	On day 3 <5 [10]
Longstreth awakening score	On admission <5 [12]
Grubb prognostic scoring system	On admission 4-6 [2]

Table 2: Practical guide for prediction of neurological outcome after cardiopulmonary resuscitation

Presenting cardiac rhythm on arrival of emergency team
Time of anoxia
Time of cardiopulmonary resuscitation
Serum blood glucose level on admission
Initial clinical neurological investigation (if possible despite of emergency treatment)
Early cerebral computed tomography for demonstration of acute central nervous system hypoperfusion signs and exclusion of haemorrhage
Serial EEG recordings
Clinical neurological investigation with special regard to pupillary reaction to light, motor response to noxious stimuli and brain stem reflexes on
day 3 after CA (if possible despite of intensive care treatment)
Somatosensory potentials on day 3 after CA

grades[1,4,16]. The accuracy of prognosis is greatest in records with mild or severe abnormalties. EEG changes observed in the early phase after arrest are of less prognostic significance than are those 2 to 3 days after CA. Serial recordings are to be recommended[4,16].

Recording of evoked potenials has been used for prognostic evaluation in patients with hypoxic coma as well[1,5]. The absence of the cortical somatosensory evoked potential N20 is highly correlated with non-survival and usually precedes electrocerebral silence.

Neuroimaging

Early CT findings of acute global CNS hypoperfusion predicting a poor outcome are diffuse mass effects, global decrease in the cortical grey matter density from edema, bilaterally low density lesions of the basal ganglia and decreased grey matter density in bilateral watershed distributions[17].

The sensitivity of magnetic resonance imaging in the detection of ischemic hypoxic lesions is greatly superior to CT[1,4,5,18]. Further neuroimaging methods, which can be useful in outcome prediction, are magnetic resonance spectroscopy[5], xenon-133 blood flow technique, hexamethylpropyleneamine oxime-single-photon emission CT, and positron emission tomography[1,4].

Long-term Survival after Cardiopulmonary Resuscitation

Although the results of numerous studies vary widely, long-term survival after CA can be expected in about 10% to 20%[1,4,9,10]. Neurologic and neuropsychological deficits after CA and successful CPR are found in approximately 20% to 50% of survivors[4,6,9].

Conclusion

Although there are a lot of parameters which can help in outcome prediction after CA, definite prognostic criteria that enable clinicians to stop treatment after CA have not been developed so far. Decisions have to be met individually in every case and the above mentioned prognostic parameters can help the clinician at this difficult task. Nevertheless, clinicians always have to consider that the decision to continue life support is reversible, but the death of a patient with the potential for recovery is a more significant error than the transient prolongation of the life of a patient destined soon to die or to remain in a chronic vegetative state.

References

1 Berek K, Jeschow M, Aichner F (1997). *The prognostication of cerebral hypoxia after out-of-hospital cardiac arrest in adults.* Eur Neurol 37: 135-145.

2 Grubb NR, Elton RA, Fox KAA (1995).*In-hospital mortality after out-of-hospital cardiac arrest.* Lancet 346: 417-421.

3 Müllner M, Sterz F, Binder M, Hellwagner K, Meron G, Herkner H, Laggner AN (1996). *Arterial blood pressure after human cardiac arrest and neurological recovery.* Stroke 27: 59-62.

4 Berek K, Aichner F (1999). *Prognosis of cerebral hypoxia after cardiac arrest.* Curr Opin Crit Care 5: 211-215.

5 Berek K, Lechleitner P, Luef G, Felber S, Saltuari L, Schinnerl A, Traweger C, Dienstl F, Aichner F (1995). *Early determination of neurological outcome after prehospital cardiopulmonary resuscitation.* Stroke 26: 543-549.

6 Berek K, Schinnerl A, Traweger C, Lechleitner P, Baubin M, Aichner F (1997). *The prognostic significance of coma-rating, duration of anoxia and cardiopulmonary resuscitation in out-of-hospital cardiac arrest.* J Neurol 244: 556-561.

7 Bell JA, Hodgson HJF (1974). *Coma after cardiac arrest.* Brain 97:361-372.

8 Yarnell PR (1976). *Neurological outcomeof prolonged coma survivors of out-of-hospital cardiac arrest.* Stroke 7: 279-282.

9 Levy DE, Caronna JJ, Singer BH, Lapinski RH, Frydman H, Plum F (1985). *Predicting outcome from hypoxic-ischemic coma.* JAMA 253: 1420-1426.

10 Edgren H, Hedstrand U, Kelsey S, Sutton-Tyrell K, Safar P and the BRCT 1 Study Group (1994). *Assessment of neurological prognosis in comatose survivors of cardiac arrest.* Lancet 343: 1055-1059.

11 Mullie A, Buylaert W, Michem N and the Cerebral Resuscitation Study Group of the Belgian Society of Intensive Care (1988). *Predictive value of Glasgow Coma Score for awakening after out-of-hospital cardiac arrest.* Lancet i: 137-140.

12 Longstreth WT Jr, Diehr P, Inui TS (1983). *Prediction of awakening after out-of-hospital cardiac arrest.* N Engl J Med 308: 1378-1382.

13 Schaarschmidt H, Prange HW, Reiber H (1994). *Neuron-specific enolase concentrations in blood as prognostic parameter in cerebrovascular diseases.* Stroke 25: 558-565.

14 Pfeifer R, Börner A, Figulla HR (2004). *Prognose nach Herz-Kreislaufstillstand.* Intensivmed 41: 171-180.

15 Gueugniaud PY, Garcia-Darennes F, Gaussorgues Ph, Bancalari G, Petit P, Robert D (1991). *Prognostic significance of early intracranial and cerebral perfusion pressures in post-cardiac arrest anoxic coma.* Intensive Care Med 17: 392-398.

16 Hockaday JM, Potts F, Bonazzi A, Schwab RS (1965). *Electroencephalographic changes in acute cerebral anoxia from cardiac or respiratory arrest.* Electroencephalogr Clin Neurophysiol 18: 575-586.

17 Kjos BO, Brant-Zawadzki M, Young RG (1983). *Early CT findings of global central nervous system hypoperfusion.* AJNR 4: 1043-1048.

18 Birbamer G, Aichner F, Felber S, Kampfl A, Berek K, Schmutzhard E, Gerstenbrand F (1991). *MRI of cerebral hypoxia.* Neuroradiology 33(suppl): 53-55.