Surviving Cardio-Respiratory Arrest:

What Are the Chances?

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Approximately 200,000 cardiac arrests will receive cardiopulmonary resuscitation (CPR) each year. While roughly 40% of these cases will be resuscitated with restoration of spontaneous circulation and respiration, only 10% to 20% will survive the year following their arrest: 11% will be discharged, and 3% to 10% will return to a normal life.[1-3] Anoxic-ischemic encephalopathy is the principal cause of mortality in at least 30% to 40 % of those who die.[4]

Knowing which patient is most likely to recover meaningful neurologic function would help in dealing with family issues and guiding subsequent management. While post-cardiac arrest prognosis remains a challenge, it has become much easier to define a population that will remain in a permanent vegetative state. However, we remain unable to predict which patients will regain not only consciousness, but meaningful neurologic function.

Assessment of prognosis

Clinical predictors

Several clinical studies have shown it is possible to predict a poor outcome—defined as a persistent vegetative state or conditions with various degrees of awareness and significant disability, including dementia and motor deficits—in a subset of patients. However, this is less definitive than a prediction of persistent vegetative state, a condition from which withdrawal of care would not be so controversial.

Daniel's Attack

Daniel, a 46-year-old with known hypertension and Type 2 diabetes, collapses on his kitchen floor. His wife, who witnessed the fall, starts cardiopulmonary resuscitation (CPR) after not finding a pulse. The ambulance arrives six minutes later.

The patient is in documented asystole. He is intubated and given adrenaline and atropine. Two minutes after administration, normal sinus rhythm returns with a pulse. The patient is then transported to the emergency department, still unconscious.

Four hours later, Daniel's blood pressure is 110/70 mmHg, and his pulse is 60 beats/min, with good oxygen saturation. A neurologic exam shows no response to pain and an absence of cranial nerve function.

Due to Daniel's wishes of being an organ donor, the family has several questions:

1. Is the patient brain dead?

2. If he is not brain dead, what are the chances of his regaining consciousness?

3. Is there likely to be residual damage?

For more on Daniel, go to page 70.

General predictors

There are a certain number of clinical factors that have an overall negative prognosis after cardiac arrest. These include:

- age over 70 years,
- known renal insufficiency,
- previous myocardial infarction, and
- the presence of active infection or pulmonary edema at the time of the arrest.

Length of time between arrest, initiation of CPR, and resumption of cardiac function

Mortality increases by 4% for every minute without CPR. When CPR is initiated within six minutes of arrest, and is successful in less than 30 minutes, 50% of patients will have an acceptable clinical outcome.[5]

Post-CPR coma

Coma lasting more than three days carries a > 90% risk of poor outcome. However, 11% of patients not initially comatose die within the year.[5]

Brainstem reflexes

The presence, or absence, of brainstem reflexes at different times after arrest are very useful in predicting poor outcome. A study involving 210 patients with anoxic-ischemic encephalopathy found that brainstem reflexes are often absent in the first hours after arrest, only to return four to 24 hours later.[6] Therefore, brain death cannot be determined during the first 24 hours.

While the absence of pupillary light reflexes at the time of initial evaluation was often indicative of a very poor prognosis, another study demonstrated that 16 of the 86 patients initially without pupillary reflexes regained consciousness, with 11 of those patients having mild to moderate deficit.[7]

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Mary Jane's Consequences

Mary Jane, 26, suddenly collapses while taking intravenous cocaine. She is brought to the emergency department where she is found to have a normal pulse and pressure, an intact brainstem, and appropriate response to pain.

One hour after arrival, she suddenly goes into asystolic cardiac arrest. The resuscitation lasts 20 minutes.

Three days later, she is still comatose. Her pupils are now unreactive and there is no motor response to pain. The family is considering withdrawing care and seeks your advice.

What would you recommend?

For more on Mary Jane, go to page 70.

Followup on Daniel

Daniel was assessed neurologically every six hours for three days. Twelve hours after the arrest, he regained all his brainstem reflexes; by 24 hours, he was moving purposefully; by 48 hours, he had regained consciousness.

One year later, Daniel is at home. He has memory problems that keep him from working, but no weakness. The myocardial infarct he sustained has left him with some dyspnea on exertion.

Mary Jane's Coma

Mary Jane has clinical signs that have a high predictive value for poor outcome. The family was told there was very little chance for any meaningful recovery. They wished to wait another two days for out-of-town family members to arrive.

In that time, Mary Jane remained in a coma and lost her corneal reflexes and occulocephalic reflexes, as well as the previous absence of pupillary response. Withdrawal of care was initiated at that time.

However, all studies have reported 100% occurrence of major deficit, vegetative state, or death when pupillary reflex remains absent after a period of three days.

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Motor function

Motor response is a highly predictive factor. A study conducted by Levi et al. found that only one of 93 patients with either no response or decorticate/decerebrate posturing to stimulation at 24 hours recovered awareness. Likewise, myoclonic status epilepticus in coma has a 96% association with a bad outcome.[8] The use of paralyzing and sedative drugs can preclude accurate assessment and need to be discontinued.

Clinical exam

While a number of algorithms have been constructed to predict outcomes at days three, seven, and 14 of the post-arrest period, one cannot make a confident, early prediction of persistent vegetative state (PVS) or death using clinical predictors alone, unless there is a considerable compromise of brainstem function. Longstreth et al. found that, if certain variables were present on admission after arrest, there was an 84% chance of a good outcome. These variables include:

- appropriate motor response to pain,
- pupillary light response,
- spontaneous eye movements, and
- a normal serum glucose.

False prediction, of good outcome, occurred in 16 (10%) patients, however, 12 of those could not live independently.[2] Overall, no clinical findings were found to have a strong predictive value of a good outcome.

Electrophysiologic predictors

Electrophysiologic tests allow a real-time assessment of cerebral cortical function in patients who cannot respond clinically.

Somato-sensory evoked potentials

The cortical N20 response to median nerve stimulation approaches the ideal prognostic test. However, while the absence of the response from median nerve stimulation is specific—nearly 100% specificity for an outcome no better than a PVS—it is not especially sensitive for a hopeless prognosis; 50% of patients

with a preserved response die without recovering awareness.[8]

Electroencephalogram

The electroencephalogram (EEG) taken immediately after arrest has no predictive value, as there have been many reports of patients with isoelectric EEGs on day one regaining consciousness with a good outcome. EEGs performed after the first day of arrest may show deteriorating patterns associated with a fatal outcome. This is consistent with the known phenomenon of delayed neuronal death, which may take more than 24 hours to develop. Subsequent EEG patterns are almost always (> 95%) associated with a bad neurologic outcome:

- generalized suppression;
- generalized burst-suppression;
- generalized periodic patterns, especially with epileptiform activity; and
- alpha or alpha-theta pattern coma.[9-15]

Biochemical/metabolic/blood flow prognostic tests

Options include:

1. Nuclear magnetic resonance (NMR) spectroscopy. Certain compounds found only in neurons can be detected by NMR spectroscopy. Preliminary evidence indicates that N-acetylaspartate reduction by seven days shows a strong correlation with neuronal loss.[16] This technology holds considerable promise for prognosis following cardiac arrest, but conclusive studies are needed.

2. Measurement of brain-derived creatine kinase, neuronal specific enolase, lactate, and other chemicals in the cerebrospinal fluid. None have proven very useful thus far.

Practical management

Aggressive ICU care

Along with optimal general care, it is important to minimize ongoing or subsequent brain damage by:

- preventing hyperglycemia and hyperthermia;
- maintaining adequate blood pressure. (Due to loss of autoregulation, adequate systemic blood pressure is essential. Hypertension may lead to cerebral edema.); and
- achieving normal arterial concentrations of oxygen and carbon dioxide. (Excessive oxygen may contribute to increased free radical damage; hypocapnia reduces cerebral perfusion and hypercapnia raises intracranial pressure.)

Take-home message

- Clinical factors which point toward a negative prognosis after cardio-respiratory arrest include:
  - age over 70 years,
  - known renal insufficiency,
  - previous myocardial infarction, and
  - presence of active infection.
- EEG taken on the first day after cardiac arrest may not show deterioration patterns associated with a fatal outcome.

Myoclonic seizures often respond to intravenous valproate, which can be given as a loading dose of 30 mg/kg. This step protects the brain and allows for later application of prognostic tests.

Neurologic assessment

A full neurologic baseline assessment on day one will allow the physician to check for good prognostic variables and follow the evolution over time.

Followup assessment on day three

If the patient is still comatose on day three, an EEG can be helpful. If the motor response is absent, if the patient demonstrates decerebrate/decorticate posture, or if pupils do not respond to light, evoked potentials will help confirm the poor prognosis.

If the patient is improving, keep up aggressive management until the neurologic exam stabilizes. If the absolute specific signs are not present, the prognosis depends on the constellation of signs previously mentioned and the evolution.

Frequently Asked Questions

1. How soon after an arrest can a prognosis be made?

Three days. The only exception is brain death.

2. When can a determination of brain death be made after an arrest, and can it be done in the emergency room?

A determination of brain death is a clinical diagnosis. It can not be made during the first 24 hours after an arrest, as the brainstem reflexes are known to return during that time. Ideally, it should not be done not in the emergency department, but in the intensive care unit.

3. What are the most useful parts of the clinical exam to determine poor prognosis after arrest, serious enough to consider withdrawal of care?

The most powerful parts of the examination are pupil response to light, motor response, and level of consciousness.

4. Is the prognosis after a respiratory arrest the same as after a cardiac arrest?

The prognosis after cardiac arrest is not at all the same as after respiratory arrest because the brain is quite resistant to pure hypoxia without ischemia, and there will be much less damage after a respiratory arrest.

In these cases, the decision to pursue care is dependent on physician judgement, preferrably with the opinion of a specialist. CME

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