# Independent Cryonics Educators Program

## 4.2: Cerebral ischemia: the 4–6-minute brain-death myth

### Definitions

"Cerebral ischemia" means insufficient blood flow to the brain.

"Neuron" is a type of brain cell that sends information throughout the body with electrical signals.

You may have come across the idea that the brain "dies" after 4 to 6 minutes without oxygen. This idea comes from the fact that resuscitation after more than 4 to 6 minutes without blood flow at normal body temperature typically results in irreversible brain injury, coma, and eventually death. However, the inability to reverse brain injury with *today's* methods does not necessarily imply brain death.

What does "brain death" mean? Brain death is the permanent, irreversible, and complete loss of brain function. This includes involuntary activity necessary to sustain life in a patient being kept on life support. Brain death requires three things: coma, absence of brainstem reflexes, and cessation of breathing. This differs from a persistent vegetative state, in which the person still has unconscious functions such as breathing and digestion.

When a patient is deprived of oxygen at normal body temperature for many minutes, and then revived, they may be diagnosed as brain dead the following day or later. Brain death was not caused by the time without oxygen. In the first minutes and even hours after cardiac death, the basic structural and chemical integrity of a brain is surprisingly good. It would be more accurate to say that brain death was caused by restarting circulation without preventing damaging side effects.

Resuscitation involves the restoration of blood circulation. This results in "**reperfusion injury**" – a cascade of injury that occurs when blood flow is restarted after cardiac arrest, especially inflammation. Inflammation shuts off blood vessels, preventing blood from reaching brain cells. Without oxygen, brain cells die over a period of hours (not minutes).

What is crucial to understand is that reperfusion injury is not inevitable. It happens in the absence of necessary interventions. Such interventions can rescue people after

longer periods without heart function. These interventions include post-resuscitation hypothermia and supportive drugs. This can extend the 4 to 5 minute window to 15 or 15 minutes and perhaps longer.

By combining post-resuscitation cooling and a complex drug protocol, scientists have shown recovery without loss of brain function was possible up to 16 minutes after the heart stops. Even after 60 minutes without blood flow, scientists have recovered normal electrical function in mammalian brains after high pressure reperfusion.

Even if brain function cannot currently be restored, future technology may repair it. We already know that living neurons can still be cultured from brains after 8 hours without blood flow. (See the *Lancet* reference below.) Loss of function under existing conditions does not mean there is lack of structure necessary to potentially repair and restart function. The basic structure of cells persists even longer than 8 hours – perhaps for several days.

Today, physicians work on patients after minutes of cardiac arrest. In the future, medical nanotechnologists could work on patients after hours of cardiac arrest.

[10/28/22]

**Sources & Resources**

Alcor Video FAQ # 8: “Doesn't the Brain Die After 4 to 6 Minutes Without Oxygen?” https://youtu.be/Ap8b-3EUwn8?list=PLyAvfL8IKsycs9yQcwIsSJp1MQv92KHwn

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**Next: 4.3: The role of pulmonary support in cryonics**

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## ICE Program Index

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