

BRAIN DEATH – AN ARTIFACT CREATED BY CRITICAL CARE MEDICINE OR THE DEATH OF THE BRAIN HAS ALWAYS BEEN THE DEATH OF THE INDIVIDUUM*

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In this presentation I will bring you back to a very basic level discussing the brain dead patient as an artefact of critical care medicine.

While preparing this talk I decided to include very basic information on how the human body and the brain die because I feel that some of our colleagues are not familiar with those physiological details. For my medical colleagues, on the other side, this information is probably very trivial and my excuses for being too superficial here.

A Couple of Introductory Theses

The death of the brain was always part of the death of the human being. In former times it was not possible and not necessary to distinguish between the death of different body systems because once the heart stopped beating, after a couple of seconds, the patient became unconscious and, as we know from animal experiments, there is only a limited time that brain integrity can survive without oxygen, blood flow and glucose. So it made no difference whether one would talk about the death of the heart or the death of the brain. These conditions were intercorrelated. The cessation of heartbeat and ventilation led to coma and death within seconds or minutes and the damage to the brain happened within the same timeframe. In older days, breathing and heartbeat were easily accessible to physicians and to lay people while coma was the only thing that gave a hint about the functioning of the brain.

Times changed, however, when resuscitation became available. With resuscitation, we can probably interrupt the process when we interact quite early. However, some phylogenetically old parts of the brain are a little more resistant to oxygen depletion and may survive longer intervals of

* The views expressed with absolute freedom in this paper should be understood as representing the views of the author and not necessarily those of the Pontifical Academy of Sciences. The views expressed in the discussion are those of the participants and not necessarily those of the Academy.

anoxia while newer parts of the brain, specifically the hemispheres, are more susceptible to injury and die. This may result in a permanent vegetative state. If the resuscitation took too long or was unsuccessful, brain death occurred, followed by the interruption of reanimation leading to the death of the remaining body systems.

Brain death, therefore, is not a new concept. The brain died with the rest of the body and it simply did not make much of a difference whether it died because it was injured first or it was injured by the cessation of, for example, heart or pulmonary function.

The problem that we are facing, and this is why the topic of brain death became so interesting, is that we are not only able to perform short time resuscitation, but also are able to replace some of the basic functions of the body with modern medical technology. We can even replace organs. We can transplant hearts and lungs. We have patients surviving with artificial hearts, waiting for their transplant, for months. One essential part of the body is not functioning anymore, a situation that would have caused death in older days, but now it can be replaced. Here is where Critical Care Medicine comes into play.

I would like to discuss ‘natural death’ versus ‘brain death’. I will talk about the definitions and about misperceptions and misunderstandings among lay people and among physicians, which frequently are based on different terminologies. Most problems that we are facing today is based on wrong definitions and wrong terminology, for example confusing persistent vegetative state with brain death.

A Primer on Physiology

The three central players in the whole game are the heart, the lung and the brain. All three are essential for the integrity and the survival of the human being. They have different characteristics.

The heart has very simple functions: it is a muscle, a machine that pumps blood into the body. It is autonomous in its action. The heart beat is automatic and may be modulated by the nervous system. This modulation, however is not needed for the heart’s survival. The heart is fully dependent on the lung, on oxygen and on the blood’s fuel, which is glucose. It needs energy and oxygen.

The lungs are also simple in their function. They are responsible for the gas exchange and oxygenation of blood. This mechanical process of breathing is generated by muscles. These muscles are activated by a tiny region in

the lower brain stem. Without the brain's signals, no breathing is possible. The respiratory drive is completely dependent upon this small area in the lower brain stem.

The brain is, as we all know, much more complicated. It has multiple functions and one of the very basic ones is the function that controls the ventilation process. The brain, this unbelievable organ, is completely dependent on blood flow from the heart carrying oxygen from the lung and glucose from other parts of the body.

In summary, there is the control of the lung by the brain stem, there is the interaction between oxygenation in the lung and blood flow that goes back and forth (without blood flow there is no oxygenation and, vice versa, without oxygen the heart will stop beating at one point in time), and finally there is the complete dependency of the brain from blood flow that is coming from the heart.

Natural Death

So how does a person die? What happens in so-called 'natural death', for example in a fatal heart attack, is quite simple. The brain is the organ that suffers immediately after the heart stops beating. The brain does not get blood anymore, it is missing O_2 and it is missing glucose. Coma will occur within seconds. This leads to a failure of the respiratory drive within and that adds to the full loss of oxygenation in the blood. All parts of the brain will quit their function irreversibly after five to eight minutes. Maybe some small areas of neurons or glial cells will survive for ten minutes. When we interfere at an earlier time point by resuscitation, then we will see some of remaining parts of the brain surviving with the well-known sequelae.

Another type of 'natural death' occurs when the lungs quit their functions, e.g. in massive pulmonary embolism. Again, O_2 is missing, the brain does not receive enough oxygen, coma is the answer. Cardiac output is also affected and the failure of the respiratory drive coming from the brain after 30 to 300 seconds leads to brain death and heart arrest. Again, all three areas are interdependent.

Everybody has always accepted massive trauma to the brain as natural death, for example a shotgun wound, a massive haemorrhage, or a massive subarachnoid haemorrhage. These conditions lead to immediate coma, loss of respiratory drive, cessation of breathing. The heart may continue to beat for maybe five or ten, sometimes twenty minutes and then stops because of anoxia (if we do not interfere).

There is no death of a human being without death of the brain. Brain death, the irreversible loss of function of all parts of the brain, was always the decisive part of any individual's death. I will use the term 'brain death' as opposed to 'loss of function' for all the other organs, for some good reasons that I would like to discuss in a minute.

Some More Definitions

Now we all agree that the death of the brain is the death of the human being and that the irreversible damage of the brain is the basis for brain death. Unlike in heart failure or pulmonary failure, a dead brain cannot be substituted by machines or transplants. Once this diagnosis is established the individual is dead and the patient is not a patient anymore. That is an important thing when it comes to psychology, like care for a brain dead body. It is, in my opinion, not care of a patient anymore and we will come back to that.

The term 'isolated brain stem death' is misleading because it does not cover the death of the whole brain. Therefore I propose to call it 'isolated loss of brain stem function'. Once the other parts of the brain are included, we may call it 'brain death' but we should not call it 'brain stem death'. The permanent vegetative state for some time can be identified with proper examination and good training, which is essential for those people who are dealing with those types of patients. Frankly it cannot be confused with brain death.

Critical Care Medicine

The most important advances in medicine in the past fifty years are imaging and Critical Care Medicine. Critical Medicine started with the simple substitution of the excursions of the thorax, which the lung will follow passively – the 'iron lung' in the polio epidemics of the 40s and 50s of last century. Oxygenation of the blood became possible although the respiratory muscles were paralyzed. In the meantime, we have much more sophisticated interventions such as extracorporeal circulation, artificial heart techniques and advanced ventilation protocols to allow individuals to live with the function of a part of the body that previously was thought to be essential for life being replaced.

We can lose the function of the lung and survive, we can lose the function of the heart and we substitute it with a machine or a transplant, and the brain may remain unhurt.

But what if the brain is irreversibly damaged? The ventilatory support of a patient who has suffered major brain damage that would eventually lead to immediate death simply interrupts the cascade that I described previously by substituting nothing else than the mechanical excursion of the chest.

The loss of brain function is now compatible with the survival of the remaining body. The loss of the respiratory drive is substituted by a machine and does not lead to complete loss of function in the remaining parts of the body. The brain has died but the lung can continue to do its job. Anoxia will not occur and the heart will continue to beat with its endogenous rhythm and that leads to a situation like those famous or notorious cases where a brain dead pregnant woman can give birth to a healthy child eight months later or six months later.

Was this still a human being? Physiologically it is not a problem. Many parts of the body may function on, while the brain is dead. This is only achievable by Critical Care Medicine. Without Critical Care Medicine this problem does not exist at all. Even nowadays, when patients do not have access to Critical Care Medicine, brain death does not exist.

I do not believe that, in a time that we all will experience, there will be a replacement for a dead brain and if there will be, it would be a replacement of a body to a brain, in my opinion, and not of a brain to a body. But this is a discussion that we probably do not need to enter today because we all will not experience a situation like that.

When we have a respirator started on such a patient, it does not substitute the brain function.

Therefore I would like to submit that the death of the brain is the death of a human being and I know that there is probably no discussion about that among us. I would also submit, that this is only true if all functions of the brain are irreversibly damaged.

The Definitions of Brain Death

The definitions of brain death are much more straightforward than the definitions of natural death. The fear that there may be wrongdoing in the diagnosis of brain death is probably less important than the fact that coroners always tell us of how many mistakes are being made when the natural death of a human being is assessed or the cause of the natural death.

Is it a problem, that there may be some cell groups not finally disintegrated? One argument regarding those potentially still viable cell groups is that we cannot assess it with other tests. Well, this is true for the death of the

body as well. All cultures have accepted for centuries and even longer, that after the death of an individual there is some growing of hair, there is some growing of fingernails. In fact, the old Nordic mythology describes that the end of the world will come when a ship built of the still-growing fingernails will arrive, with a sail woven from the still-growing hair. Do we have to care about a little group of cells in the brain that is still sending some electrical signals? Think of the fact that the semen of a recently dead man can still be used for artificial insemination. Obviously, some cells are viable but that will not hinder us to say this patient is dead. I would like to take this example and carry it forward to the clusters of nervous cells somewhere in the brain that may still be there for five or eight or twenty more minutes.

The German rules for brain death take care of the question of training. In Germany we need to have two independent and experienced investigators, who must have training in the critical care of nervous diseases. Neurologists and neurosurgeons take care of that, and that is part of the training. Training takes care of experience, there is no such thing that someone drops by and does not know the examination of a brain dead patient. This certainly makes the diagnosis even safer in our hands. We have different observation times for different causes of brain death. It is different when you have a primary injury to the central nervous system – the observation time is shorter – than if you have a secondary insult. Ancillary tests can be used and in some specific situations they are required for example in isolated brain stem functional loss, where an EEG is required. Of course, precautions including intoxication, hypothermia and so on exist like in others.

Brain Death: Concerns and Misperceptions

Relatives of patients frequently do not accept that their loved one is going to die. When we start talking about transplantation, their idea is that you will let the patient die in order to harvest organs! There was very bad press about that when we had the discussion about the new transplantation law in Germany and people really stood up and described patients who were not brain dead that would be considered organ donors.

You may have noticed that, until now, I have not talked about transplantation, because I feel the concept of brain death is not exclusively linked to transplantation. For us it is an important area also for utilisation of resources on an ICU. We cannot go on to ventilate someone who is brain dead and is not a candidate for organ transplantation because of sepsis, because of HIV, because of metastatic cancer and so on. If they

have or developed a brain death syndrome the same rules apply and the same decisions are needed afterwards. Interestingly, the group of people who usually accuse critical care physicians of overuse of critical care facilities not allowing people to die now blame us of 'stopping critical care prematurely to harvest organs'.

How to deal with a brain dead patient actually, I submit, this is semantically wrong: It is not a 'brain dead patient' because it is not a patient anymore. It was a patient, it was a human being and now it is a dead body. And this dead corpse needs the same dignity and the same behaviour from our side that we would offer to every demised former person. There is also no specific need for nursing in this situation, unless we have organ-preserving therapy, if organ donorship is an option. But otherwise, this is not a patient anymore. If no transplantation is planned, organ support – it is not life support anymore – should be terminated after close counselling with the relatives who are now the ones who need our attention much more than the former patient.