

# Chapter 14

## Brain Death

### Introduction

The diagnosis of death is, in most countries, the legal responsibility of a medical practitioner. It marks a point in time after which consequences occur including no medical or legal requirement to provide resuscitation or life-sustaining technologies, loss of personhood, and most individual rights, the opportunity for organ donation and autopsy proceedings, execution of the decedent's legal will, estate and property transfer, payment of life insurance, final disposition of the body and, of course, religious, or social ceremonies to mark the end of a life [1].

A definition of death, just like a definition of life, continues to elude philosophers. Death can be considered in terms of medical, legal, ethical, philosophical, societal, cultural, and religious rationales. The medical definition of death is primarily a scientific issue based on the best available evidence [2].

### Definition of Death

Death is defined by almost all cultures and religions as the departure of the soul out of the body. The old Egyptians, Chinese, Hindus, Judaism, Christianity, and Islam agreed to this definition, but they differed on the concept of soul and whether it will depart into another body or remain in limbo until resurrection when it will go back to its old body with new formulation that will give it the ability for life forever.

Both the Hellenic and Judeo Christian cultures identified death with the departure of soul from the body. In 1957, Pope Pius XII speaking to an International Congress of Anesthetists, raised the question of whether one should continue the resuscitation process despite the fact that the soul may already have left the body [3].

In Islam death is the departure of the soul out of the body. The soul is created by Allah (God) but remains afterwards eternal and will not die, but will either be

chastised or eulogized until the day of resurrection when it will be reunited with the body for a new eternal life either in Hell or Paradise.

The embryo and fetus has a vegetative and then animated life but will not have a human life except after ensoulment which only occurs at 120 days from the moment of conception (fertilization) as narrated by Prophet Muhammad (PBUH) [4]. Ibn AlQaiym said: If it is asked “Does the embryo before breathing of the soul unto it, has a life? It is answered that it has a vegetative life like a growing plant. Its movements and perception are not voluntary. When the soul is breathed in it acquires sentience and volition” [5].

It is clear that the embryo and fetus has a pumping heart and circulation long before ensoulment occurs. The circulation and pumping heart denote a lower level of life (vegetative or even animated but not a human life which only occur after ensoulment and which is directly connected to the higher functions of the brain). As death is defined as departure of the soul out of the body, and as the soul cannot be identified by mortal human beings, the signs accompanying this departure are looked for, the most important of which is the irreversible loss of respiration. The word “nafs” in Arabic means Soul, and the word “nafas” means Respiration and if respiration (nafas) ceases irreversibly then the “nafs” (the soul) has left the body.

There are other signs described by the Islamic Jurists like glaring of eyeballs (the vision following the soul as it departs), limpness of the feet, bending of the nose, whitening of the temple, etc. [6]. These signs are not definite of death. The important sign is the irreversible loss of respiration plus the irreversible loss of consciousness.

Christopher Pallis conceived human death as a state in which there is irreversible loss of the capacity of consciousness combined with the irreversible loss of the capacity to breath [7]. The concept is a hybrid one, expressing both Philosophical and Physiological attributes.

It also agrees with the old observation of linking “nafs” (soul) with “nafas” (respiration) as already explained. The irreversible loss of consciousness and responsiveness to external or internal stimulation is of paramount importance.

Clinical examination should provide evidence of the irreversible damage of the brain especially the brain stem. (These will be discussed later in more detail).

Death is a result of the irreversible loss of these functions in the brain; either from an intracranial cause such as trauma or hemorrhage, or from an extracranial cause such as cardiorespiratory arrest, where impaired cerebral perfusion will culminate in cerebral and brainstem damage.

There is growing consensus that there is a unifying medical concept of death; all human death is anatomically located to the brain. That is, human death involves the irreversible loss of the capacity for consciousness, combined with the irreversible loss of the capacity to breathe. These two essential capacities are found in the brain, particularly the brainstem, and represent the most basic manner in which the human organism can sense and interact with its environment [8].

The most appropriate set of criteria to use is determined by the circumstances in which the medical practitioner is called upon to diagnose death. The three criteria sets are somatic (features visible on external inspection of the corpse), circulatory

(after cardiorespiratory arrest), and neurological (in patients in coma on mechanical ventilation); and represent a diagnostic standard in which the medical profession and the public can have complete confidence [9].

## **Brain Death: Medical Background**

Although it is more than 40 years since the concept of brain death was first introduced to clinical practice, many of the controversies that surround it have not been settled. These include the relationship between brain death and death of the whole person, the international differences in the nomenclature and criteria for the determination of brain death, and the inextricable links between brain death and organ donation [10].

The development of organ transplantation and the associated need to determine death before organ retrieval led to the publication of the first widely accepted standard for the confirmation of brain death by an ad hoc Committee of the Harvard Medical School in 1968 [11]. Although this early link with organ donation might give the impression that brain death was a construct designed only to facilitate donation, this is incorrect. Most importantly, the confirmation of brain death allows the withdrawal of therapies that can no longer conceivably benefit an individual who has died.

In the UK, a Conference of the Medical Royal Colleges and their faculties produced guidance for the diagnosis of brain (stem) death in 1976 [12] and, in a subsequent memorandum 3 year later, equated brain death with death of the whole person for the first time [13]. In the USA, the 1981 Uniform Determination of Death Act (UDDA) gave equivalence to death determined by neurological and cardiovascular criteria, although it did not mandate a standard by which brain death should be determined, confirming only that this should be in accordance with accepted medical standards [14].

The UDDA relies on the whole-brain formulation and states that “an individual, who has sustained irreversible cessation of all functions of the entire brain, including the brain-stem, is dead.”

This forms the standard for the determination of death by neurological criteria in the USA and most European countries and is based, in theory at least, on confirmation of the loss of all brain function including, but not limited to, the brainstem [15].

Unlike whole-brain death, the diagnosis of brainstem death, such as that used in the UK, does not require confirmation that all brain functions have ceased, rather that none of those functions that might persist should indicate any form of consciousness [16].

The determination of brainstem death requires confirmation of the “irreversible loss of the capacity for consciousness combined with the irreversible loss of the capacity to breathe” and relies on the fact that key components of consciousness and respiratory control, the reticular activating system and nuclei for cardiorespiratory regulation, reside in the brainstem [17].

Death is not a single event but a process that leads progressively to the failure of all functions that constitute the life of the human organism. There have always been individuals that do not accept that brain death equates to the death of the individual.

Initially, it was argued that brain death equates to the death of the individual because, after brain death, the body ceases to be an integrated organism and rapidly becomes a disintegrating collection of organs which have permanently lost the capacity to work as a coordinated whole [18]. However, it is now clear that brain-dead patients can show levels of somatic integration that may persist for some time [19, 20].

The US President's Council on Bioethics proposed a new unifying concept of death in 2008. The Council reiterated its support for a whole brain formulation and rejected a reliance on brainstem death, arguing that the inner state of a person with residual cortical activity in the complete absence of brainstem activity is unknown.

## **Preconditions for the Diagnosis of Brain Death**

Before proceeding to make the diagnosis of Brain Death, the following conditions should be present:

- Patient in deep coma, and the cause of the coma firmly established.
- The patient has no spontaneous respiration and is on the ventilator.
- The event causing brain death occurred at least 6 h previously and the cause of death has been established.
- Complete areflexia (spinal reflexes excepted).

### Exclusions

- Core body temperature above 35.5 C.
- Toxicology testing for drug overdose, narcotics, alcohol and hypnotics should be done in unexplained cases of coma or in road traffic accidents. If no toxicology lab is available and there is suspicion of drug overdose, an interval of 5 days should lapse before testing for brain death.
- The patient should not be receiving any sedatives, muscle relaxants, hypnotics, narcotics, or antidepressants.
- Patients with metabolic and endocrine causes of coma should be excluded until the metabolic and endocrine derangements corrected.
- Patients shall not have any signs of cerebral activity like decerebrate or decorticate posture and seizure activities.
- Patient is not in cardiovascular shock.
- No physician should determine brain death in patients with a (possible reversible) septic shock or rapidly proceed with testing in patients seen soon after arrival in the emergency department [21].

### Clinical Assessment

1. Lack of response to stimulation (spinal reflexes excepted).
2. Absence of brain stem reflexes:
  - a. Fixed pupils to light
  - b. Corneal reflexes
  - c. Occulocephalic reflexes
  - d. Occulovestibular reflexes (50 ml of ice cold water)
  - e. Gag reflex
  - f. Cough reflex
  - g. Apnea test: absence of spontaneous breathing when the patient is disconnected from the ventilator for 10 min so that the arterial CO<sub>2</sub> pressure is more than 50 mm of Hg (Pa CO<sub>2</sub> 54 mmHg) i.e. hypocapnia is excluded. At the same time O<sub>2</sub> is administered through a catheter into the trachea. This test is only done at the end of the second examination and confirmatory tests performed. It is mandatory to repeat the clinical tests by two consultant Physicians and done separately.

### Confirmatory Tests (Required in Saudi-Arabia and some other countries)

- EEG of 30 min duration should be silent or
- Absence of blood flow to the brain proved by Doppler or cerebral angiograms or CT Angiography or MRI Angiography, etc.

The period between the two tests depends on the age of the patient:

1. Infants: (7 days to 2 months) : 48 hours confirmed by two flat EEGs
2. Infants: (2 months to 1 year) : 24 h confirmed by 2 flat EEGs
3. 1 year-Puberty: 12 h confirmed by one flat EEG
4. Adults: 6 h confirmed by one flat EEG

As the EEG denotes cerebral activity, it is imperative to confirm the absence of blood flow to the brain by cerebral angiography or CT Angio or MRI angio or Doppler.

Both clinical examinations should be completed and signed by the two consultants Physicians conducting the tests (Neurologist, Neurosurgeon, Anesthetist, or Intensivist).

The Executive Medical Officer (CMO) or designee should countersign, before any supportive means are disconnected. The relatives of the brain dead person should be approached tactfully to either donate organs of their beloved one or to disconnect the deceased from the ventilator. The Fatwas of the ulema and Islamic Jurisprudence Councils which allow disconnections of the machines help the relatives to accept the diagnosis. However, many relatives ask for continuation of ventilation and management until asystole occurs. This is a big burden on the staff, expense to the community and deprivation of the machines when the sources are limited.

### Differences in Establishing the Diagnosis

Despite general consensus on the concept of brain death, there are major international differences in its diagnosis. The majority of countries have followed the lead of the USA and the UK in specifying that the clinical diagnosis of brain death is sufficient for the determination of death in adults [21].

While there is unanimity that confirmation of the absence of brainstem reflexes is fundamental to the clinical determination of brain death, there are wide variations in the requirements for the conduct of the apnea test. This is concerning because the confirmation of apnea is fundamental to the determination of brain death (either whole brain or brainstem) and this can only be assured if the degree of acute hypercarbia is sufficient to stimulate the respiratory centre.

A second clinical examination is required in many countries and this was presumably introduced to minimize the likelihood of errors in diagnosis.

However, while there is no convincing evidence that a second test is necessary, there is evidence that it delays the determination of brain death [22]. A second apnea test is not required in some countries that mandate two clinical examinations, but omission of this crucial component from one of the examinations is illogical. The mandated time interval between the two examinations also varies. While a 24 h period is usual after hypoxic-ischemic brain injury, the time frame is already mentioned depending on the age of the individual.

Some brain death guidelines specify the qualification and level of experience of those determining death, and most explicitly exclude anyone involved in organ transplantation.

The number of doctors required to determine brain death also varies widely, although most commonly a single doctor is sufficient. Two doctors (the UK standard) are required in only around one-third of countries. Some jurisdictions mandate that two different doctors must determine brain death only when organ transplantation is being considered. There is variability in the diagnostic criteria for brain death reported between hospitals and different countries.

### Confirmatory Tests

It is widely accepted that brain death is a clinical diagnosis and that confirmatory laboratory tests are recommended when specific components of the clinical testing cannot be evaluated. An ideal confirmatory test should be safe, accurate, and inexpensive [23]. Confirmatory investigations generally fall into two general categories. These either demonstrate the loss of electrical activity of the brain or confirm the absence of intracerebral blood flow [24].

Confirmatory tests are optional in most countries and reserved for circumstances where some doubt exists about the clinical diagnosis of brain death (e.g. after infusion of long-acting sedative drugs such as thiopental) or because the patient might be too unstable to undergo an apnea test [25].

In clinical practice, EEG, cerebral angiography, nuclear scan, transcranial Doppler (TCD), CT Angiography (CTA), and magnetic resonance angiography (MRI/MRA) are currently used ancillary tests in adults. Most hospitals will have the

logistics in place to perform and interpret an EEG, transcranial Doppler, nuclear scan, or cerebral angiogram, and these tests may be considered the preferred tests. Transcranial Doppler is the easiest and cheapest.

CT-A is easily accessible in almost every hospital, offers a high spatiotemporal resolution, is operator independent and inexpensive. The results of CT-A are comparable to other established brain perfusion techniques in brain death [26].

Ancillary tests can be used when uncertainty exists about the reliability of parts of the neurologic examination or when the apnea test cannot be performed. The interpretation of each of these tests requires expertise. In adults, ancillary tests are needed to confirm the clinical diagnosis of brain death. Physicians ordering ancillary tests should appreciate the disparities between tests and the potential for false-positives (i.e., the test suggests brain death, but the patient does not meet clinical criteria).

Rather than ordering ancillary tests, physicians may decide not to proceed with the declaration of brain death if clinical findings are unreliable [27]. Ancillary tests may play an important role in shortening periods of observation, but the Subcommittee of the American Academy of Neurology concluded that there are not enough data to show that newer tests confirm the termination of whole brain functioning.

Confirmatory tests are not specifically recommended in current UK guidance and it is time for a broad debate on the role, type, and application of ancillary tests and publication of consensus guidance that has professional support [28]. The High Committee on brain death in Saudi Arabia insists on performing an EEG before establishing the diagnosis of brain death. Other ancillary tests are optional.

We think that confirming the absence of intracerebral brain flow e.g. by transcranial Doppler is feasible, inexpensive and will reduce the resistance against accepting brain death as death.

## Islamic Views of Brain Death

Death etymologically means departure of the soul out of the body, and cessation of the signs of life. Al-Ghazzali (d 505 AH/1111 CE), an influential Islamic scholar, says that separation of the soul from the body is the end of its dominance over the body [29].

According to Al-Ghazzâlî and all Muslim Scholars, the event of death occurs when the soul is separated from the body [30]. Thus, the event of death is just a ‘change of state’. The fact pointed out by certain Qur’anic verses and hadîths (prophetic traditions) pertaining to this subject that death is not simply a type of change; but the soul separated from the body is either in a state of punishment, or in a mode of blessing [31].

The Islamic faith values human life. It values any means to save a human life, and condemns the termination of a human life without just cause: “And kill not anyone whom God has forbidden, except for a just cause (according to Islamic law)” [32]. Muslim scholars who advocate organ donation commonly cite the verse:

“if anyone killed a person—not in retaliation of murder, or (and) to spread mischief in the land—it would be as if he killed all mankind, and if anyone saved a life, it would be as if he saved the life of all mankind” [33] and emphasizing the latter, i.e., the saving of a human life being of a paramount value with such actions to be rewarded as if they involved the saving of the whole of mankind [34].

Is brain death equal to cardiopulmonary (traditional) death or is brain death just an intermediate state between life and death?. Which formulation, whole-brain or brain-stem death, is consonant with Islamic bioethics?. Finally what are the clinical responsibilities of physicians to patients in these states? [35]

An Islamic consensus on brain death is lacking. Some equate brain death with cardiopulmonary collapse, both being death proper in Islamic law. Others hold brain death to be an in-between state between life and death, where life support need not be continued, while some have rejected the concept in toto [36].

The Fatwa of Khomeini and Mufti of Egypt in early sixties allowed procurement of organs from “dead” persons with the classical definition of death with irreversible cardiac and respiratory failure and followed by death of the whole body. Iran officially accepted “Brain Death” in 2003.

In their Fatwa of 1982, The Senior Religious Scholars of Saudi-Arabia mentioned only obtaining organs from living and dead donors. They never recognized “Brain Death” as “Death” up till now. However, they allowed stopping the ventilators and resuscitative measures. When the heart and circulation stops, then organs could be retrieved if the family agrees.

Two of the most influential bodies of Islamic bioethicolegal deliberation are the Organization of Islamic Conferences’ Islamic Fiqh Academy (OIC-IFA) and the Islamic Organization of Medical Sciences (IOMS). Both organizations bring together scholars of Islam and medicine for Islamic ethico-legal deliberation around bioethical challenges faced in the Muslim and non-Muslim world.

The first discussion of Brain Death started by Islamic Organization for Medical Sciences (IOMS) in Kuwait in 1985 and both the The Islamic Fiqh Academy of the Organization of Islamic Conference (OIC-IFA) and The Islamic jurist council of Islamic World League, Makkah started then to discuss the issue of Brain Death.

During a 1985 meeting of the Islamic Organization for Medical Sciences (IOMS) Islamic scholars and medical scientists equated brain stem death, and allowed for removal of life support [37].

The Fatwa of the The Islamic Fiqh Academy of the Organization of Islamic Conference on resuscitation apparatus (October 1986) incorporated the concept of brain death into the legal definition of death in Islam:

[A] Person is pronounced legally dead and consequently, all dispositions of the Islamic law in case of death apply if one of the two following conditions has been established: (1) there is total cessation of cardiac and respiratory functions, and doctors have ruled that such cessation is irreversible; (2) there is total cessation of all cerebral functions and experienced specialized doctors have ruled that such cessation is irreversible and the brain has started to disintegrate [38].

Some Muslim countries adopted this definition of death after the enactment of the Uniform Determination of Death Act (UDDA) in the United States, which

stated that: An individual who has sustained either (1) irreversible cessation of circulatory and respiratory functions, or (2) irreversible cessation of all functions of the entire brain, including the brain stem, is dead. A determination of death must be made in accordance with accepted medical standards. (National Conference of Commissioners on Uniform State Laws 1981).

The Islamic jurist council of Islamic World League allowed in 1987 stopping the ventilators in brain dead persons. It resisted taking organs from brain dead patients. The Pulmonary Circulatory death should be announced first; then organs could be taken if the relatives agree.

This Fatwa concurs with the Fatwa of High Scholars of Saudi Arabia (including the grand Mufti Sheikh Bin Baz) which was passed in 1983, and allowed stopping the ventilators from brain dead persons, as it was considered futile to continue hooking such persons to machines; but death will not be announced until after the stoppage of circulation and respiration [39].

The IOMS revisited the issue in 1996 after they sent three members to participate in an international bioethics conference. These members reported back to the IOMS, this time with some eminent Islamic Scholars attending the meeting including Sheikh Yousef Al-Qardawy, Sheikh Khaled Al-Mathkoor, Professor of Islamic Law in Kuwait University, Dr. Ibrahim Ali Hasan, the Vice President of the High Government Council in Egypt, and Dr. Abdullah Al Isa, Vice President of the High Court of Kuwait. (Dr. Mohammed Albar had the privilege of presenting a paper in that meeting as well).

The meeting was called for because an Egyptian professor of Anesthesia (Dr. Safwat H Lutfi) campaigned against brain death both in the medical circles and media (newspaper, television and public meetings) in Egypt, and stirred antagonism against the physicians who wanted to take organs from poor people and give them to wealthy persons for money!! It was then discussed by Al-Azhar and the parliament which was about to accept brain death. He succeeded in stopping this approval. He was called to Kuwait to attend this meeting and IOM sent a delegation of three people to attend an international conference on brain death held in San Francisco, 21–25 November 1996 to obtain an update on the subject.

Utilitarian reasoning would be invoked to facilitate end-of-life organ procurement because "...it is a pity to waste such candidate cadavers without trying to save the life of many others who need their organs" [40].

The Islamic Medical Association of North America (IMANA) also contributes to the discussions of brain death through an Islamic lens. IMANA's support of brain death is as follows: A person is considered dead when the conditions given below are met... A specialist physician (or physicians) has determined that after standard examination, the function of the brain, including the brain stem, has come to a permanent stop, even if some other organs may continue to show spontaneous activity [41].

In summary, the literature most accessible to practicing clinicians uses the OIC-IFA and IOMS assessments as support for brain death within Islamic law [42]. It is important to note that no mention of brain death was available in Islamic countries before 1985. All the discussions since the time of Ibn Sina (Avicenna) and Nawawi were on death of the whole person.

## Controversies in Brain Death

Despite its name, the Universal Determination of Death Act has not been universally accepted. Ethicists and physician experts have taken issue with the concept of brain death and the medical standards by which it is diagnosed. Some feel that the clinical examination alone is insufficiently sensitive to detect loss of all brain function and that ancillary tests of cerebral blood flow or electroencephalographic activity should be mandatory [43]. Others feel that we are too lax in our definition of “all functions of the brain” and that we inappropriately declare dead patients in whom neuroendocrine function persists. Still others feel that brain death is an artificial construct created expressly for the purpose of generating more organ donors and creating the illusion of moral soundness [44].

The public must believe that the priority of the medical system is to save lives rather than to obtain organs to feel confident that they would become organ donors only after all reasonable attempts to save their lives have failed.

Strict adherence to published guidelines and medical standards for determining brain death is the minimum requirement for maintaining public trust [45].

A person should be declared (brain) dead because he or she is in fact dead, rather than because of any potential for organ donation. In this way, the professional and legal acceptability of withdrawal of treatment (including mechanical ventilation) which is merely prolonging somatic function can be assured. The recently updated Code of Practice in the UK has separated completely the diagnosis and confirmation of death from issues surrounding organ donation and this is helpful.

### Opponents of Brain Death concept

The Muslim opponents of Brain Death concept criticize it in several points:

I. They claim that the 2010 update of the American Academy of Neurology guidelines for determining brain death fail to meet the three essential requirements stated in the Islamic definition of death: (1) total cessation of all brain functions, (2) irreversibility of cessation, and (3) the onset of disintegration of the brain [46].

The opponents argue that there are two consequences of using a medically faulty criterion of death in organ donation. First, organ procurement is performed in the operating room with no general anesthesia because donors are presumed dead [47]. To avoid Lazarus Phenomenon, most surgeons require general anesthesia to procure organs from brain dead individuals.

Second, donors are not legally dead if they do not fulfill the criterion of death stipulated in the Resolution of the Council of Islamic Jurisprudence on Resuscitation Apparatus (1986).

Padela et al. [48] have pointed out the serious gaps in contemporary medical understanding and clinical diagnosis of brain death and its endorsement as human death in the Islamic faith. These gaps pertained to: (1) the retention of residual brain functions; (2) the recovery of some previously ceased brain functions; (3) the absence of whole brain degeneration and necrosis; and (4) the uncertainty of medical tests and bedside examination in determining this condition with reasonable accuracy [49].

Bedir and Aksoy [50] concluded that brain-dead patients should be cared for as living humans who could still suffer from surgical procedures performed on them. Prof. Sachedina has acknowledged that the Western concept of death that equated brain death with human death was incompatible with Islamic teachings because: .... the Qur'anic view of human person, the nafs [soul], that rejects the dichotomization of human personality into a body and mind, is at the root of theological debate on the relationship between life and death. As a nafs who dies through the divine decree any definition of this nafs's death must focus on the criteria that determines the death of the whole human rather than just a part of his biological existence. In other words, no definition of death that fails to take a living person, as seen in the Qur'an, can have a valid ground for acceptance in Islamic jurisprudence [51].

II. The opponents say that: the guidelines should reliably establish the irreversible cessation of all functions of the entire brain including the brainstem, yet neither "irreversibility" nor "function of the brain" (or "of the entire brain") is defined. Both of these terms have engendered unresolved controversies. The American Academy of Neurology Subcommittee does not identify the gold standard by which sensitivity, specificity, and predictive accuracy of the guidelines as a diagnostic tool are measured, with respect to either the irreversibility or the totality aspects. This gold standard does not and will never exist in the opinion of some authorities. Therefore, diagnostic guidelines for brain death are inherently unable to be validated through an evidence-based methodology [52].

III. Some state that there is mounting scientific evidence that neither the Neurological Standard (namely, whole brain or brain stem death) nor the circulatory criteria (namely absent arterial pulse and circulatory arrest for 2–5 min), specifically developed to declare death for procuring transplantable organs, is consistent with human death [53, 54].

In medical practice, there are two types of end-of-life organ donation.

The first is called "heart beating organ donation" and is performed on a person with spontaneously beating heart and circulation after declaring death using a Neurological Standard of whole brain (in USA) or brain stem death (in Europe).

The second is called "non-heart beating organ donation" and is performed on a person who has controlled or non-controlled cessation of spontaneously beating heart and absent arterial pulse of 2–5 min. However, there are scientific flaws with this criterion: (1) the heart is capable of recovering its mechanical function and spontaneous regular beating, and (2) the whole brain, including the brainstem, can remain viable after 2–5 min of absent arterial pulse [55, 56]. Therefore, the ceased physiological functions of the cardiovascular, respiratory, and neurological systems are reversible at the time of procuring organs from non-heart-beating donors.

This criterion was opposed by The High Committee on brain death in Saudi-Arabia.

IV. The opponents state that the concern regarding the validity of the clinical criteria has been reinforced by a recent report of 2 cases of well-documented clinical brain death with return of spontaneous respiration during the period of preparation for organ harvesting [57].

## Rebuttal

I. The authors of the updated American guidelines state that: The gold standard for the diagnosis of brain death is a neurologic examination and irreversible loss of all brainstem function. They never claimed that the clinical examination of brain death implies loss of all neuronal function [58].

II. The American Evidence-based guideline update published in 2010 stated that “in adults, there are no published reports of recovery of neurologic function after a diagnosis of brain death using the criteria reviewed in the 1995 American Academy of Neurology practice parameter.” All “recovered” adult cases reported in the literature and those in the media are suspect due to presence of confounders, no detailed description of testing, or no mention of the apnea test [59, 60].

Dr. Martin Smith from Queen Square, London confirms that: “The criteria for the determination of brain death are robust” [61]. He also states that the recent reports describing the apparent “reversibility” of brain death have been refuted because of failure to adhere to such standard guidelines [62].

The authors of the updated American guidelines also states that rare cases of brain death claimed to being reversible have been reported [63–66]. These cases report transient return of some neurological function after a diagnosis of death using neurological criteria [67]. In some cases, the details are unclear regarding whether an acceptable apnea test was performed. In two infants aged 3 months, apnea testing was adequately described, and brain death confirmed for >24 h, with later return of some brainstem function [68]. Together with the other report in an infant aged 10 months, these three cases illustrate that brain death as currently diagnosed can be reversible [69]. The author of one of these reports clearly says that “It should be noted that in most cases of children pronounced brain dead these guidelines are not followed” [70].

The outcome in these three cases with a confirmed apnea test and reversal of brain death was dismal, with profound brain injury, and ultimate death [71].

Recommendations for brain death determination may require revision for infants, to more clearly define a time interval between examinations and to incorporate consideration of confounding sedative drug effects.

III. The preservation of spinal and autonomic (cardiovascular) function and reflexes after the diagnosis of death using neurological criteria has led to concern by some clinicians that this residual function represents evidence for continued or potential consciousness. There is overwhelming evidence that continued spinal cord activity, including complex withdrawal movements (Lazarus sign), is possible and indeed expected after a diagnosis of death using neurological criteria [72, 73].

IV. The continued secretion of pituitary hormones observed in some cases of confirmed “brain death” is not a surprise, since anatomically the posterior pituitary and, to a lesser degree the anterior pituitary (indirect partial supply via short portal vessels), is supplied by the inferior hypophysial artery, which is extra-dural in origin [74, 75].

## Conclusion

Although guidelines are available in many countries to standardize national processes for the diagnosis of brain death, the current variation and inconsistency in practice make it imperative that an international consensus is developed. This should clarify the criteria for the determination of brain death and provide specific instructions about the clinical examination necessary and the conduct of the apnea test. It should also stipulate the role and type of confirmatory investigations, and detail the required level of documentation. An international consensus on the determination of brain death is desirable, essential, and long overdue [76].

Following established guidelines scrupulously can maintain the foundation of a transplantation system that saves thousands of lives a year [77]. Confirmatory test is mandatory to establish the absence of blood flow to the brain by cerebral angiography or CT Angio or MRI angio or Doppler. Infants diagnosed as Brain Dead should have a longer period (48 h) for the second test, prior to declaration of Brain Death.

On the issue of equating brain death with human death, the Islamic jurist council of Islamic World League held in Makkah Al Mukaramah (December 1987), which passed Decree No. 2, did not equate cardiac death with brain death. Although it did not recognize brain death as death, it did sanction all the previous Fatwas on organ transplantation. It allowed harvesting organs if the circulation stops irreversibly [78].

Islamic juridical deliberations around brain death largely took place over 25 years ago in response to medical developments and ethical controversies in the Western world. As these developments have been transplanted into Muslim contexts, the debates within Muslim bioethics need both updating and deepening with regard to the early rulings on brain death [79].

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75. The adenohypophysis receives the majority of its blood supply from the paired superior hypophyseal arteries, which arise from the medial aspect of the internal carotid artery, within the ophthalmic segment. The neurohypophysis is supplied by the inferior hypophyseal arteries. These vessels are terminal branches of the meningohypophyseal trunk, which arises from the cavernous portion of the internal carotid artery. The hypophyseal portal veins drain the primary capillary plexus formed by the superior hypophyseal arteries, which deliver blood to the pars distalis. The pars distalis in turn houses the secondary capillary plexus. Thus, a portal venous system allows delivery of hypothalamic prohormones to the adenohypophysis, and the neurohypophysis secretes hormones directly into the venous draining system of the pituitary
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