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Medical Aspects of Brain Death

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As an introduction to the halachic discussions that will follow on the subject of brain death, it is imperative to have a thorough understanding of the subject matter involved. I hope to present the information in an objective, unbiased fashion, explaining the medical knowledge as it exists today. Halacha cannot be judged in a vacuum and thus, *poskim* who will tackle such difficult questions will need a working knowledge of the basic medical facts. In my opinion, some of the earlier ambiguities in halachic opinions may have resulted from a lack of concise, clear, and rigid criteria for brain death in the medical literature. These criteria have now been standarized, refined, and verified, and will be briefly reviewed. The discussion will focus on adults and on children older than five years.

Historically, the definition of death was not an issue until about thirty years ago. Upon cessation of spontaneous respiration or heart beat, death (neurologic or otherwise) would invariably follow shortly thereafter. With the advent of artificial respiratory support, patients were being kept "alive" who had suffered extensive irreversible brain damage associated with permanent loss of respiration. The only detectable sign of life in these patients was continued spontaneous heart beat with associated maintenance of blood pressure (though now even the latter can be maintained to a certain degree with various medications). Thus, the question arose

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as to whether these patients were, in fact, dead or alive.

The famous Harvard criteria were first introduced in 1968. There have been numerous reviews of these criteria as medical science has advanced, but the basic structure remains intact. The Harvard criteria have attained almost universal acceptance by medical societies, state legislatures, ethicists, and most religious groups. Thus, a patient who fulfills these medical criteria is considered by the secular world as medically, morally, ethically, and most important, *legally* dead.

What are the driving forces compelling us (physicians and society at large) to redefine death along neurologic lines? As systemic death will always follow true brain death shortly thereafter, why the hurry to pronounce death a few hours or at most a few days before? Aside from the obvious question of whether death has taken place, there are at least three other important factors.

1. Financial and triage considerations — maintaining a brain dead (i.e. dead) patient in an intensive care unit or even a regular hospital bed is extremely costly — both fiscally and physically. In this era of soaring medical costs and hospital occupancy rates over 90 percent, there is great pressure to reduce expenditures and free up much needed beds. Some contend that valuable staff time (attendants, residents, nurses etc.) would be better spent on more salvageable patients.

2. Social — there is great anguish and suffering involved for relatives and friends of these patients who are maintained with respirators and multiple other unsightly paraphernalia in the twilight zone of brain death. Though I am not certain as to the significance of this as a halachic problem, it is an important consideration in the secular world.

3. Organ transplantation — at present, cardiac and liver donation is possible only from the brain-dead donor. Cessation of spontaneous heartbeat renders these organs unfit for transplant. With over 80 percent five-year survival rates in transplant patients, these transplant procedures are life-saving and almost routine. The pressure on hospital personnel to help locate donors and procure organ donation is very intense. In fact, New York State Public

Health Law requires administrators to request organ donation from family members of appropriate patients who die in the hospital.

Clincial Aspects

The President's Commission for the Study of Ethical Problems in Medicine and Biomedical and Behavioral Research published guidelines for the determination of death in 1981. The Uniform Determination of Death Act states:

> 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 brainstem, is dead. The determination of death must be made in accordance with acceptable medical standards.

In simpler terms, the first definition is the one with which we are all familiar. A patient stops breathing or the heart ceases to beat either unexpectedly or associated with a terminal illness, and the patient is dead. The second newer definition, requires that *both* the "upper" brain (cerebral hemispheres) and the "lower" brain (brainstem) cease to function (Figure 1). The patient may then be declared dead.

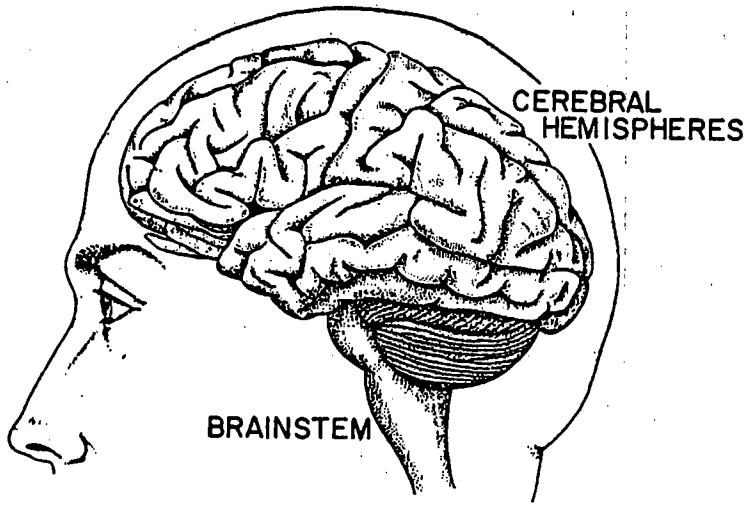

TABLE I

Criteria for Determination of Death (Adapted from the President's Commission)

An individual presenting the findings in either Section A (cardiopulmonary) or Section B (neurological) is dead. In either section, a diagnosis of death requires that *both* cessation of functions and irreversibility be demonstrated.

A. Cardiopulmonary (traditional definition of death)
   1. Cessation recognized by appropriate examination
   2. Irreversibility — persistent cessation of function for an appropriate period of observation and/or trial of therapy

B. Neurologic (modern definition of death)
   1. Cessation — must have a and b.
      a. Cerebral functions are absent
      b. Brain stem functions are absent
   2. Irreversibility — must have a, b, and c.
      a. Cause is established and sufficient to account for brain dysfunction
      b. Possibility of recovery is exluded
      c. Persistent cessation of function for appropriate period of observation and/or trial of therapy

The Commission outlines criteria for this determination as seen in Table 1. Though established as "advisory," these criteria are generally accepted and executed in their present form throughout the country. We will analyze these criteria in a bit more detail and reference will be made to them during the ensuing discussion.

B 1a : Cerebral functions are absent — the cerebral hemsipheres (upper brain regions) are the seat of consciousness, and thus profound unresponsivenes (deep coma) must be present.

This alone, however, is not "brain death," as the brainstem (lower brain regions — see Figure 1) may still be functioning. Numerous medical conditions can render a patient profoundly unresponsive (i.e. comatose) yet not affect lower brain function (e.g. liver or kidney failure, mineral, imbalance in the blood, severe infections alcohol intoxication, drug overdose, etc.). Of greater significance is that many of these conditions are potentially reversible. Thus, in addition to profound unresponsiveness, a second absolute prerequisite for brain death must be met.

B 1b.: Brainstem functions are absent — brainstem dysfunction is determined by clinical examination confirming the absence of the so called "cephalic" reflexes (pupillary, corneal, vestibulo-ocular, and gag) and absolute, irreversible absence of spontaneous respiration. The details of these procedures are not appropriate for the present discussion; however, it is sufficient to state that the examination is standardized and easily performed by experienced physicians (generally neurologists or neurosurgeons). The central focus here is on the ability to breathe. With a relatively simple bedside procedure (apnea testing) it can be demonstrated that the region of the brainstem responsible for control of respiration is permanently and irreversibly dead. There cannot be, now or ever, return of independent breathing. In contrast, the heart, which is an *independent* organ, will continue to beat spontaneously. Thus, the only apparent detectable sign of "life" in the brain-dead individual is continuous, spontaneous heart beat.

The above examination fulfills the requirement for cessation of function of the cerebral hemispheres and the brainstem. Now it remains to be proven that this cessation is irreversible beyond doubt.

B 2 a,b,c : The presence of brain death should not be certified unless the underlying cause is identified (e.g. severe head trauma, or patient postcardiac arrest who was "successfully" resuscitated), and there is no chance of reversibility. As noted previously, several conditions can closely simulate brain death, and these must be excluded. In addition, an appropriate period of time must pass, which varies from 6-24 hours in different centers.

Laboratory Evaluation

1. Electrophysiological testing

a. Electroencephalogram (EEG=brainwave) — this most commonly used test measures electrical activity of the cerebral hemispheres (upper brain regions) only and plays no role in evaluating the brainstem. It is a common *misconception* in both lay and non-neurological medical circles that a "flat" EEG is diagnostic of brain death. Though firm technical requirements have been set up by the American EEG Society for determining a "flat" EEG, pitfalls exist which need to be considered. For example, a "flat" EEG can be seen in patients with severe drug overdose even when brain death is not truly present (so-called false positive). Alternatively, several authors have reported occasional persistent minimal EEG activity in the presence of true brain death (so-called false negative). Thus, with certain limitations, the EEG is a valuable confirmatory measure of brain death in experienced hands in the proper clinical setting.

b. Evoked potentials — without exploring these procedures in detail, it is sufficient to say that these tests are useful in evaluating the functional electrical integrity of the brainstem. These confirmatory tests can be performed at the patient's bedside.

2. Cerebral blood flow studies

The presence and absolute irreversibility of brain/brainstem death can be confirmed by demonstrating the complete absence of blood flow to the brain. The most direct and reliable method is with cerebral angiography (injecting dye directly into the large blood vessels that feed the brain). In most cases, the four vessels which normally bring blood to the brain are abruptly cut off before entering the skull. However, because there is no actual flow of blood, the veins that drain blood from the brain are never seen. This test is the "gold standard" against which all other non-angiographic flow studies are compared. Unfortunately, it is usually impractical (or impossible) to perform angiography routinely as it requires transporting a comatose, respirator-dependent patient to the radiology section of the hospital. Thus, various radioisotope techniques have been used to test cerebral blood flow in a safer,

simpler manner at the bedside. In simple terms, this involves injecting a radioactive substance into a peripheral vein and following its course with a special scanning device as it flows into the brain. A disadvantage of this method is that the *brainstem* circulation is not well visualized and thus absolute absence of flow to this region may not always be diagnosed with certainty. Various other modalities (including Xenon enhanced computed tomagraphy, digital angiography, transcranial Doppler) have been tried for brain death confirmation but are not widely used as yet.

Pathology

The most common finding in patients with brain death is the so called "respirator brain." The pathological features consist of a mixture of swelling and destruction and are related to the duration of time spent on the respirator after cerebral blood flow ceased. It is, in fact, not the respirator that leads to "respirator brain" but lack of blood flow and oxygen. Thus, a brain studied soon after brain death may be almost normal in appearance.

Conclusion

None of the above information necessarily suggests whether neurological/brain death is in fact equivalent to the traditional criteria of death. Brain death can be diagnosed with certainty and it is equally assured that all patients rigidly meeting criteria for brain death will systemically die in a matter of hours or a few days. That is — in the respirator-supported brain- dead individual whose heart continues to beat spontaneously, circulatory collapse will inevitably follow in short order. However, whether the *neshama* (soul) leaves the body at the moment of brain death or later, with cessation of heart beat, is a halachic question, not a medical one.