

Appendix 1. Tests to Determine the Time of Brain Death

The determination of the moment of death by objective measures of brain function (“brain death”) requires total and irreversible cessation of all brain functions including the brain stem. One must, therefore, clarify the cause for the catastrophic and irreversible brain damage and must rule out possible reversible causes (such as serious abnormalities in basic gas exchange, acid-base balance or hormonal functions). One must also rule out drug overdoses which may depress all central nervous system functions. The patient should also not be suffering from hypothermia, and all the tests to determine brain death should be performed at a body temperature above 32°C or 90°F (1).

Brain death is only determined by three definite findings:

- coma and total non-reactivity to the surrounding environment
- total absence of brain stem reflexes
- total absence of spontaneous respiration (apnea).

The tests to determine **coma and total non-responsivity** to painful stimuli involve primarily observing the patient’s reaction to painful stimuli (the complete test for this condition is called the Glasgow Coma Scale = GCS).

The examinations of **brain stem reflexes** include the following tests:

- the size of the pupils and their reaction to light
- the movement of the eyeballs in response to rapid movements of the head (oculocephalic reflex) and in response to the placing of cold water in the ear (cold caloric test)

- the reaction of the eye muscles in response to corneal stimulation (corneal reflex)
- the vomiting and coughing response to stimulation of the pharynx and larynx (cough and gag reflexes).

Testing for the absence of **spontaneous respiration** is performed by providing pure oxygen to the patient's tissues through the breathing tube in the throat (2) and by observing the patient's respiration following an 8-10 minute period after the partial pressure of carbon dioxide in the blood is reduced below 60 mm of mercury (3). If the patient sustained serious internal injuries or has previous pupillary abnormalities or serious previous pulmonary diseases or was given medications which depress cognition and wakefulness, one cannot use the aforescribed apnea test to confirm brain death with certainty.

In such cases, and in cases where a more precise determination of brain death is needed, one uses a variety of other **diagnostic laboratory tests**, primarily of two types: a) tests which measure the absence of blood flow to the brain, since ten minutes without blood is known to produce irreversible destruction of brain cells, provided the body temperature is normal; b) tests which show the absence of electrical activity of the brain including the brain stem.

The first group of tests include the following tests:

- brain scans using radioactive substances injected into the patient's veins (radionuclide brain scanning). This test is accurate, is not associated with complications, and can be performed at the bedside without moving the patient (4)
- computerized tomography of the brain and its major blood vessels using various techniques (For example: SPECT is single photon emission computed tomography; MRI is magnetic resonance imaging; MRS is magnetic resonance spectroscopy; MRA is magnetic resonance

angiography; PET is positron emission tomography; CT is computed tomography). These techniques provide extremely accurate high resolution pictures of the brain. They are not associated with complications. Some provide data about cerebral blood flow. Their disadvantage is that the patient has to be moved to perform the tests (5).

- testing of the blood flow through the brain through the use of Transcranial Doppler sonography. This can be done at the bedside and is non-invasive but requires considerable expertise (6).
- the taking of pictures of the blood flow in the cerebral blood vessels (cerebral angiography). This is an invasive and accurate technique, but may be associated with complications (7).

The second group of tests include the the following tests:

- measurement of the electrical activity of the brain (EEG = electroencephalogram) (8).
- measurement of the electrical activity of the brain stem in response to auditory stimuli (BAER = brainstem auditory evoked response) (9).
- measurement of the brain's electrical activity following stimulation of peripheral nerves in the hand (SEP = somatosensory evoked response) (10).

To establish and confirm the irreversibility of brain death, the tests should be repeated after a six hour interval.

The clinical criteria for the establishment of brain death in **children** have been promulgated by a number of medical and legal organizations in the United States (11). In addition to the clinical signs of brain death as described for adults, other tests must be performed to confirm the irreversible nature of the condition according to the child's age, as follows:

- a) Between 7 days and 2 months of age: two sets of clinical examinations together with the apnea test in addition to two electroencephalograms (EEG), with an interval of 48 hours between the tests.
- b) Between 2 and 12 months of age: as above with a 24 hour interval between tests, provided cerebral radionuclide angiography shows no blood flow to the brain.
- c) Older than 12 months: two sets of clinical examinations together with apnea tests, with a 12 hour interval between the tests.

The determination of brain death in newborns in the first week of life is extremely difficult because the clinical signs and laboratory tests are not absolutely diagnostic. Hence, serious reservations have been expressed about the determination of brain death in newborns (12).

Appendix 2. Israel's Chief Rabbinate and Brain Death

Early in 1985, the Israeli Minister of Health and the Director of Neurosurgery at Chaim Sheba Medical Center in Tel Hashomer approached the Chief Rabbinate requesting them to describe the Jewish legal (*halakhic*) attitude toward heart transplants in Israel. They asked the Chief Rabbis whether *halakhah* considers death of the respiratory center in the brainstem to be equivalent to total body death (13). The Chief Rabbinate assembled a council of prominent Rabbis and physicians (14).

The Council held a number of meetings, heard testimony from a variety of experts in neurology, anesthesiology, surgery, cardiology and transplantation. The conclusions of the deliberations of the Council were presented to the Chief Rabbinate in Jerusalem on November 3, 1986. The Chief Rabbinate unanimously confirmed the recommendation of its organ transplant Council. This ruling was widely publicized in rabbinic journals (15) and by individual members of the Council (16). The text of the Chief Rabbinate's ruling follows (translated by Yoel Jakobovits. See *Tradition*, Vol. 24, Summer 1989):

Greater Jerusalem,

1 *Heshvan*, 5747

The Chief Rabbinical Council, which convened on 1 *Rosh Hodesh Mar Heshvan*, 5747, unanimously confirmed the recommendations of [its] Transplant Committee, as follows:

1. The Chief Rabbinate of Israel was asked by the Ministry of Health to establish the *halakhic* position with respect to heart transplants in Israel. Towards this end the Chief Rabbinate appointed a joint committee of rabbis and physicians which studied the relevant medical and *halakhic* issues. The committee was aided with the advice and counsel of leading specialist physicians on the faculty of Hadassah and Sha'are Zedek Hospitals in Jerusalem.
2. With the dawn of the heart transplant era (17 years ago) Rabbis Moshe Feinstein and Issar Y. Unterman ruled forbidding heart transplants. [They] regarded such procedures as tantamount to double murder: of the donor and of the recipient.

In the last decade several fundamental changes have occurred with respect to the [relevant] medical facts regarding heart transplants:

- a. Operative success *vis* the recipient approaches 80% at one year (“*hayeh olam*”) and 70% survival at five years.
 - b. It is possible today to confirm in an absolutely reliable and secure manner that cessation of respiration in a dying person is final and irreversible.
 - c. Evidence has been brought before us that even Rabbi Moshe Feinstein, in later years, permitted heart transplant procedures in the United States. Similarly, we are aware of leading Rabbis who have actually advised cardiac patients to undergo heart transplantation.
3. Since this inquiry [literally] involves life and death decisions, it behooves us to formulate the *halakhic* position clearly and with confidence, in spite of the enormous difficulties.
 4. Based upon the talmudic principles of *Yoma* 85, and [ruled accordingly in Responsa] *Hatam Sofer* in *Yoreh De'ah* no:338, the *halakha* holds that death occurs with cessation of respiration. (See also Responsa *Iggrot Moshe*, *Yoreh De'ah* III, no:132.) Therefore one must confirm that respiration has ceased completely and irreversibly. This can be established by confirmation of destruction of the entire brain, including the brain stem which is the pivotal activator of independent respiration in humans.
 5. It is accepted in medical circles that such confirmation (as mentioned in paragraph 4) requires five conditions:
 - a. Definite knowledge of the etiology of the brain damage.

- b. Complete cessation of natural respiration.
 - c. Detailed clinical verification of brainstem destruction.
 - d. Objective and established scientific tests of brainstem destruction, such as BAER [Brainstem auditory evoked responses].
 - e. Evidence of complete cessation of respiration and of absent brainstem function for at least 12 hours, in spite of continued standard intensive care.
6. After considering the proposals for establishing death according to the guidelines of the medical staff of Hadassah Hospital in Jerusalem dated 8 *Tammuz*, 5745, and submitted to the Chief Rabbinate on 5 *Tishre*, 5747, we find that these can be *halakhically* acceptable provided that we add a scientific objective test (BAER) of the brainstem.
7. In light of what has been said, the Chief Rabbinate of Israel is prepared to authorize heart transplants (from motor vehicle victims) at the Hadassah Medical Center in Jerusalem under the following conditions:
- a. Realization of all the conditions for establishing death of the donor as stated above.
 - b. Participation of an appointee of the Chief Rabbinate of Israel as a full member of the committee which established donor death. This appointee shall be chosen by the Ministry of Health from a list submitted to it annually by the Chief Rabbinate.
 - c. Prior written consent for heart donation should be provided by the donor or his family.

- d. The creation of a higher review committee on behalf of the Ministry of Health with the participation of the Chief Rabbinate to investigate all instances of heart transplants in Israel.
 - e. The Ministry of Health shall establish within the civil law all the above mentioned protocols.
8. Until the conditions specified in paragraph 7 are accepted, there shall be no sanction of heart transplants in Israel.
9. When permission is granted, upon satisfaction of the conditions specified in paragraph 7, the Chief Rabbinate will establish a review committee to insure full compliance with the conditions of the sanction.

Supplements:

- A. The criteria for establishing brain death as recommended by Hadassah, Jerusalem.
- B. The protocol for performance of the BAER.

Appendix 3. Rabbi Shlomo Zalman Auerbach's View on Brain

Death

The background upon which Rabbi Shlomo Zalman Auerbach zt"l based his ruling on brain death is the talmudic assertion (17) that the fetus of a pregnant woman who dies a natural death always dies before the mother. Nowadays, it is know that a live fetus can be born to a pregnant

woman who is brain dead. Hence, brain death seems not to be a halakhic definition of death.

With the technological advances in medicine including respirators and other life support equipment, the question posed to Rabbi Auerbach was whether or not a dead woman nowadays who is being artificially ventilated can give birth to a living child. He suggested that a pregnant sheep be decapitated while it is attached to a respirator and its heart is functioning normally, and that its offspring be delivered one half hour later (18). The successful experiment showed that the talmudic assertion refers to natural death under ordinary circumstances. However, in an intensive care unit with artificial respirators, it is possible for a pregnant woman defined as dead to give birth to a live baby.

Rabbi Auerbach's view was widely discussed and publicized (19). The following is the text of his ruling (20):

- 1) Brain death as it is nowadays determined by physicians is not sufficient to establish the death of a person. Such an individual is legally like a *safek met* (possibly dead) and *safek goses* (possibly terminally ill). Therefore, it is prohibited to hasten the death of such a person in any manner. It is also forbidden to remove organs for transplantation as long as the heart is still beating for fear of hastening the death of the *goses*. This act is forbidden even for the need to save the life of another extant patient who would otherwise certainly die. Therefore, in Israel, where [physicians and others] are not careful about all these details, yet are aware that halachic rules must be followed, it is prohibited to be a candidate to receive an organ donation.

- 2) In the following circumstance, it is permissible in some cases to remove organs for transplantation, and in other cases to only serve as a recipient of an organ from a patient whom physicians have determined to be brain dead:
- a) In the Diaspora, since most physicians and patients are not Jewish and conduct themselves according to their medical knowledge and standards, it is permissible for a Jew to be an organ recipient and to receive organs to save his life even if he knows that the organ donor is Jewish (21).
 - b) If a person is actually decapitated or if the entire brain is outside [the skull], even if the heart is still beating [the person is dead and his organs may be removed for transplantation].
 - c) When brain death is established after all the currently accepted medical tests have been performed, it is then permissible to remove the mechanical respirator - and if it is clear that the patient lies like an inanimate stone and does not breathe spontaneously, and one waits until the heart stops beating completely for half a minute - if one can successfully revive the heart, one may use [that patient's] organs for transplantation.
 - d) If in the future a test is discovered which can definitively and unequivocally determine that all brain cells are dead without any doubt, and if after removal of the respirator it is apparent that the patient does not breathe for thirty seconds - and, in addition, if the test itself does not violate the laws of a *goses*, that is to say that the test does not involve moving the patient or injection of a substance into the body -

one might consider whether this situation is equivalent to decapitation and then allow organ transplantation from such a corpse even if the heart still beats.

References and footnotes

1. American Academy of Neurology, *Neurology* 45:1012, 1995.
2. Concerning the importance of oxygen flow through the tube in the trachea in the performance of this test, see SJ Marks and J. Zisfein, *Arch Neurol* 47:1066, 1990.
3. Concerning the details of this test, see American Academy of Neurology, *Neurology* 45:1012, 1995 and EFM Wijdicks, *Neurology* 45:1003, 1995.
4. See J. Korein et al., *Ann Neurol* 2:195, 1977; BH Holzman et al., *Neurology* 33:1027, 1983; JM Goodman et al., *Neurosurgery* 16:492, 1985; RH Reid et al., *J Nucl Med* 30:1621, 1989; A Yatim et al., *Transplant Proc* 23:2491, 1991; MS George, *Eur J Nucl Med* 18:75, 1991. See also F Rosner and MD Tendler, *J Halacha Contemp Soc* No. XVII, Spring 1989, pp. 14ff.
5. See GF Mulinari, in J Toole (Edit.): *Handbook of Clinical Neurology*, Vol. 55, Amsterdam, Elsevier, 1989, pp. 255-274; S Ashwal et al., *Ann Neurol* 25:539, 1989; C Pallis, in R Braakman (Edit.): *Handbook of Clinical Neurology*, Vol. 57, 1990, pp. 441-496; F. Aichner et al., *Ann Neurol* 32:507, 1992.
6. See NM Bornstein and JW Norris, *Ann Neurol* 51:1057, 1994; LR Wechsler and VL Babikian, *Ann Neurol* 51:1054, 1994; M Feri et al., *Crit Care Med* 22:1120, 1994.

7. See GB Bradac and RS Simon, *Neuroradiology* 7:25, 1974; I. I. Kricheff et al., *Ann NY Acad Sci* 315:168, 1978.
8. See the Ad Hoc Committee of the American Encephalographic Society, *Neurology* 20:525, 1970. This was one of the earliest tools for brain death. In recent years it has been supplemented by more sophisticated tests. See C. Pallis, *BMJ* 286:284, 1983. See also MM Grigg et al., *Arch Neurol* 44:948, 1987; J Ogata et al., *J Neurol Neurosurg Psychiatry* 51:646, 1988.
9. See American Academy of Neurology, *Neurology* 45:1012, 1995.
10. See D Goldie et al., *Neurology* 3:248, 1981; R Firsching et al., *Electroenceph Clin Neurophysiol* 84:321, 1992.
11. American Bar Association, American Academy of Neurology, American Neurological Association, American Academy of Pediatrics, Child Neurology Society. All these groups were part of a Task Force for the determination of brain death in children. See *Pediatrics* 80:298, 1987; *Ann Neurol* 21:616, 1987; *Arch Neurol* 44:587, 1987; *Neurology* 37:1077, 1987; *Pediatr Neurol* 3:242, 1987. See also S. Ashwal and S. Schneider, *Adv Pediatr* 38:181, 1991. Not all scientists agree, however, see S Ashwal and S Schneider, *Pediatr Neurol* 3:5, 1987; JM Freeman and PC Ferry, *Pediatrics* 81:301, 1988; DA Shewmon, *Ann Neurol* 24:789, 1988.
12. JJ Volpe, *Pediatrics* 80:293, 1987; FI Clark and LW Desch, *Pediatrics* 85:1126, 1990.
13. D Michaeli, *Michtav Lechaver*, Vol. 49, folio 8, 5749, p. 8.

14. See Rabbi M Eliyahu, *Barkai*, Vol. 4, 5747, p. 18 and A Steinberg, *Assia*, folio 53-54, *Elul* 5754, pp. 5ff concerning other views expressed by some members of the Israeli Chief Rabbinate.
15. *Techumin*, Vol. 7, 5746, pp. 187ff; *Barkai*, Vol. 4, 5747, pp. 11ff; *Assia*, Vol. 6, pp. 27ff; *Assia*, Vol. 7, 5754, pp. 123ff. The English translation by Y Jakobovits appeared in *Tradition* 24(4):1ff, 1989.
16. See Rabbi M Eliyahu, *Barkai*, Vol. 4 5747, pp. 18ff; Rabbi S. Yisraeli, *Barkai*, Vol. 4, 5747, pp. 32ff and *Assia*, folio 42-43, *Nissan* 5747, pp. 95ff; Rabbi E Shapira, *Or Hamizrach*, folio 36(1), *Tishri* 5748, pp. 67ff and *Assia*, folio 53-54, *Elul* 5754, pp. 17ff; M. Halperin, *Assia*, Vol. 7, 5754, pp. 125ff; A Steinberg, *Assia*, folio 44, *Nissan* 5748, pp. 56ff and *Assia*, folio 53-54, *Elul* 5754, pp. 5ff.
17. *Arachin* 7a.
18. For details of the actual procedure, see A. Steinberg, *Assia*, folio 53-53, *Elul* 5754, pp. 11-12. See also A Steinberg and M Hersch, *Transplant Proc* 27:1886, 1995.
19. A. Steinberg, *Assia*, folio 53-54, *Elul* 5754, pp. 13-16. These matters were discussed twice with Rabbi Auerbach who authorized the public dissemination of his opinion. See the editor's note in *Assia*, folio 56, *Tishri* 5756, p. 123. See also *Assia*, folio 53-54, *Elul* 5754, pp. 21ff and pp. 26ff.
20. As described by A. Steinberg, *Assia*, folio 53-54, 5754, pp. 13ff.
21. See *Assia*, loc. Cit., note 8 for the explanation.