Definition and Determination of Brain Death
Summarized from the ANZIC statement on Brain Death and Organ Donation, Version 3

Brain death is...
- Unresponsive coma
- Absence of brain stem reflexes
- Absence of respiratory centre functions
- Clinical setting which suggests that these findings are IRREVERSIBLE.
  i.e. there must be evidence of brain pathology consistent with irreversible loss of neurological function.

There are preconditions; to be brain dead, you must be
- Normothermic (over 35 degrees)
- Normotensive (MAP >60)
- Not sedated
- Not paralyzed
- Not in a state of electrolyte derangement (e.g. hypoglycaemia)
- Possessing at least one intact eye and one ear (to examine brainstem reflexes)
- Able to breathe (to test for apnoea; i.e. high C-spine injury may disqualify you)

The ANZICS statement reports that there has never been a documented case of anybody who fulfilled the above brain death criteria, and the preconditions for brain death, who has ever recovered any brain function.

Brain death is also...
- Absence of intracranial blood flow

Brain death is NOT...
- Decerebrate or decorticate posturing
- Extensor or flexor responses to painful stimuli
- Seizures

After 30 days of age, the same rules apply to children and to adults. In early neonates, younger than 30 days, 48 hours is the minimal period of observation (not 24).

In premature newborns (before 36 weeks) brain death testing cannot be performed with certainty.
Clinical Testing for Brain Death
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- The clinical testing takes place AT LEAST 24 hrs after a cardiac arrest
- Prior to 24 hrs, an arrested patients’ brain death can be determined by demonstration of absent cerebral blood flow

First, you watch them for 4 hours.
- A brain-dead patient will have
  - GCS of 3
  - Unresponsive pupils
  - Absent cough reflex
  - No spontaneous breathing efforts

Then, two qualified doctors test the patient.
- These doctors must establish
  - Unresponsive Coma
  - Absent brain stem reflexes
  - Apnoea

Testing for Comatose Unresponsiveness
- Painful stimulus in cranial nerve distribution, eg. supraorbital nerve pressure
- Painful stimulus in all 4 limbs, eg. nailbed pressure
- There should be no response
  - There may be spinal reflexes; these will only be triggered by painful stimulus in the 4 limbs.
  - The spinal reflexes will NOT be triggered by painful stimulus in the cranial nerve distribution

Brain Stem Reflex Testing: these are tested in sequence. All reflexes must be absent.
- Pupil Light Reflex:
  - Pupil constricts in response to light. Cataract surgery is no contraindication
- Corneal Reflex:
  - Eye blinks in response to the cornea being touched. The cornea, not the sclera.
- Trigeminal Pain
  - Painful stimulus over the supraorbital nerve. There shouldn’t be any grimacing.
- Vestibulo-ocular reflex
  - Examine the ear: auditory canal must not be blocked.
  - Put the head at 30 degrees.
  - Put ice-cold water into the ear
  - Watch the eyes for 60 seconds: in brain death, they will remain midline.
    - The “dolls eye test” is a sub-maximal stimulus of the same reflex
- Gag reflex
  - Poke the posterior pharynx, both sides.
- Cough reflex
  - Stimulate the trachea with a soft suction catheter...this wont work in people with a high spinal cord injury, as the efferent limb is severed

Testing for Apnoea – ONLY if there are no brainstem reflexes
- Preoxygenate with 100% FiO2 for 5 minutes, and then turn off the ventilator.
- Continue supplying oxygen via T-piece or something similar. Watch for absent breaths.
- After 10 minutes, make an ABG to demonstrate that the CO2 is rising.
- PaCO2 rises by 3mmHg every minute of apnoea. At 60mmHg, the respiratory centre is maximally stimulated.
- To qualify for brain death, apnoea must persist despite adequate respiratory stimulus.
Radiological Testing for Brain Death
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- Two doctors have to do this: one who performs the imaging, and another who reports the scan

**Four-vessel Intra-Arterial Angiography**
- Gold standard; injection of contrast into both carotids and both vertebrals
- No blood flow above the carotid siphon or above the foramen magnum

**Nuclear Medicine Scans**
- Absence of intracranial perfusion: Tc-99 HMPAO compound gets absorbed by the brain; its lipophilic, and when it crosses the blood-brain barrier, it becomes hydrophilic, and is thus retained.
- Tc-99m pertechnetate is not a useful radionuclide, as it does not cross the blood-brain barrier
- SPECT is the modality of choice (single photon emission computerized tomography)

**Contrast CT and CT Angiography**
- There must be contrast enhancement of the external carotid arteries, but not of the peripheral intracranial arteries and central veins
- There are no false positives, but there may be many false negatives.

**MRI**
- There is potential risk of false positives, and so this is not recommended.

**Transcranial Doppler**
- Inaccurate and operator-dependent, but can be used for screening.
Organ Donation

Summarized from the ANZIC statement on Brain Death and Organ Donation, Version 3

GIVE trigger: GCS under 5, intubated, ventilated, and with end-of-life discussions in progress.
In NSW, the two doctors determining brain death can't be involved in the tissue removal or the care of the organ recipient, and must have practiced medicine for at least 5 of the last 8 years. Furthermore, one of them must be a designated specialist in that hospital.

Things that disqualify you from being a donor:
- HIV infection
- Creutzfeldt-Jacob Disease
- Metastatic or “incurable” cancer
- Malignancy which has a high risk of metastasis no matter how long the disease-free period, eg. melanoma or choricarcinoma

You can still donate organs even if...
- You have hepatitis B or C
- You had cancer, and it has been treated successfully a long time ago
- You are in your early eighties

…but what if you aren’t brain dead, but you wanted to donate organs?

**Donation after cardiac death**

Criteria:
- Ventilated, and treatment is about to be withdrawn
- Once treatment is withdrawn, death is expect to follow quickly (because if it doesn't, the warm ischaemia time is exceeded, and the organs are of no use)
- Nothing disqualifies you from being a donor

Only Maastricht criteria 3 and 4 patients are eligible
- Category 1 are “dead on arrival” – unknown warm ischaemia time, organs are probably useless.
- Category 2 failed resuscitation in ED – also unknown warm ischaemia time.
- Category 3 have treatment withdrawn in ICU – controlled, known warm ischaemia time
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The decision to withdraw treatment must be made INDEPENDENTLY of the decision to donate organs.

- Kidney, lung and pancreas grafts survive as often as with brain-death donation, but the function of the organ takes longer to establish (eg. the kidneys don’t start working until several days after grafting)
- Liver grafts don’t do as well
- **WARM ISCHAEMIA TIME:** from treatment withdrawal until cold perfusion of the organs.
  - No greater than 30min for liver
  - No greater than 60min for kidney/pancreas
  - No greater than 90 minutes for lung

Try to avoid calling it “organ harvesting”. This has agricultural connotations.
Life after Brain Death: health of the organ donor

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- **First, you are hypertensive.**
  - This is the autonomic storm: hypertension, tachycardia, etc. Its due to brainstem compression
  - This should **not** be treated with long-acting agents. Esmolol or nitroprusside are good.

- **Then, you are hypotensive.**
  - Sympathetic outflow ceases, and there is vasodilation
  - **Vasopressors are encouraged. Use noradrenaline.**
  - Fluid resuscitation should be conservative if you plant to donate lungs, and aggressive if you plan to donate kidneys.

- **Diabetes Insipidus develops**
  - The posterior pituitary is necrotic; thus, vasopressin is not being generated, and you become polyuric. The urine you produce is sodium-poor; and therefore you become gradually more and more hypernatremic and dehydrated. This can damage the donor kidney.
  - **Replace vasopressin early (you can even run an infusion)**
  - **DDAVP (desmopressin) = 2-4 micrograms every 2-6 hours**

- **Hypothermia sets in**
  - Whole body heat generation drops (the metabolic rate decreases as the brain and denervated muscle no longer produce much heat). Plus, heat cannot be retained by autoregulatory vasoconstriction or shivering.

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