# BRAIN DEATH
## a minimal standard

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## Brain Death
## general definition

- Brain death, irreversible break down of all brain functions including brain stem
- EEG-isoelectric line
- Circulatory arrest in brain vessels
- Waiting period between 2 to 6 hours (Europe)
  - Exclusion-for extension to 12 hours (children, hypothermia etc.)
  - Exclusion for reduction-to 1 hour (severe brain damage-gun shot, etc.)
- Accepted for whole Europe and all American countries
- Brain stem death official diagnoses in UK , and some other countries.

## Brain Death
## general definition

Brain Death is stated in patients where continuing treatment of a patient is without any hope of regaining any level of brain function. A continuation of therapeutic measures in Brain Death is neither in the interest of patient nor ethical permissable. To treat a living corpse is unethical, it reduces a human being „ to a mere collection of organs" Shewmon (1998).

Shewmon (1998) : „Chronic Brain Death" :

56 Brain Death patients more than 1 months, 7 patients over 6 months , for more than 1 year , 1 patient 14,5 year.

## Brain Death
## different terms

| | |
|---|---|
| Mollaret und Goulon (1959) | „Le Coma Dépassé" |
| Committee of Harvard Medical School (1968) | „Brain Death" |
| Ingvar (1971) | „Brain Death" |
| The Conference of Medical Royal Colleges and Faculties UK (1979) | „Brain Stem Death" |
| The Subcommittee of A.A. N. for quality standards (1995) | „Whole Brain Death" |

## Brain Death
## legal definition

The diagnosis of brain death is established by the medical community according to current standards of scientific and medical practice (Haupt & Rudolf, 1999)

Diagnoses supported by strict verification of clinical symptoms, confirmed by experienced neurologists, EEG obligatory, TCD facultative, accepted by national laws.

European Preposition for Brain Death (EFNS Task Force)

Minimal Standard for Brain Death diagnoses (WFN Research Group) for countries without developed neurological services.

## Brain Death
## differential diagnoses

- Brain Death: irreversible loss of brain functions and brain stem functions.
- Death of brain is the death of a particular human organ, „critical organ" the „central integrator"
- Function of brain cannot be sustained even for a while with extraordinary care (Wijdiks, 2001).
- Total cession of brain and brain stem is based on an irreversible substantial damage of brain and brain stem.
- Differential diagnoses: apallic syndrome/vegetative state
- Locked in Syndrome, Minimal Response Syndrome (Giacino et al., 1991).

## European preposition of Brain Death
### Special Interest Group on Ethics in Neurology

- Symptoms of Brain Death
- Classification of basic pathological process
- Clinical course of Brain Death
  initial stage and full stage.
- Additional examinations
  EEG obligatory, TCD facultative,
  Additional examinations in the intitial phase-MRI etc.
- Prerequesits (protocoll of stepwise examinations)
- Selection of indepedent medical team

## Symptoms of Brain Death
### European Preposition

**1 Symptoms**
- Coma (no alertness, no conscious activities)
- No response to sensory-sensitive stimuli
- No spontaneous motor actions, including brain stem regulated
  - primitive motor patterns
  - Areflexia – extremities, trunk
  - Atonia of skeleton muscles
  - Idiomuscular contractions (facultative)
- No brainstem reflexes
  - Pupils, maximal wide, without any reaction,
  - Oculo-cephalic and vestibulo-ocular reflexes absent
  - Tracheal reflex absent
  - Apnoe (demonstrable)
- No cerebral blood circulation
- Total vegetative dysregulation (hypothermia-poikilothermia, systemic blood circulation, sometimes drug assisted)
- Autonomic cardiac function
- Spinal reflexes (facultative in 60 %)

**2 EEG:** isoelectric line
**3 TCD:** zero flow (facultative)
**4 Waiting period:** 6 hours

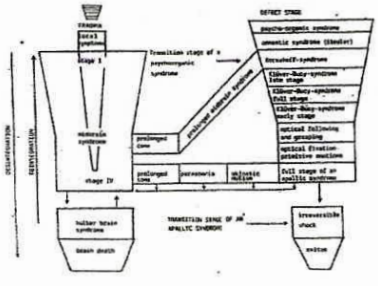
## Brain death
### classification of actiology

- Traumatic brain injury
- Encephalitis, different aetiology
- Hypoxia
- Hypoxaemia
- Brain tumour
- Subarachnoidal haemorrhage
- Haematoma, cerebral
- Brain and brain stem infarction
- Intoxication (exogenous, endogenous)
- Poisoning (venoms, plant toxins)
- Relaxation treatment (Baclofen pump system, etc.)
- Anesthesia accident
- Hypothermia, exogenous

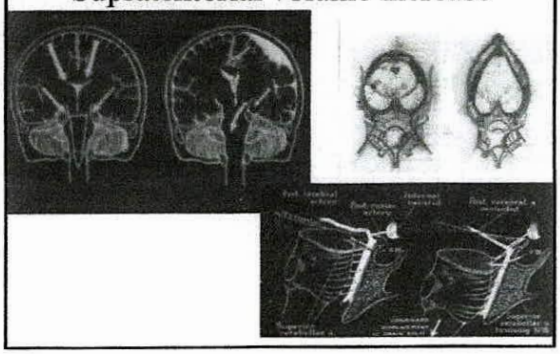
Clinical course in the development of Brain death syndrome, the irreversible break down of brain and brain stem functions

- Initial stage
  Acute midbrain syndrome, 5 phases
  Midbrain –upperpons stage (Plum & Posner)
  Acute bulbarbrain syndrome, 2 phases
  Medullary stage (Plum & Posner)
- Full stage of brain death syndrome, irreversible breakdown of brain and brainstem functions, identical with acute bulbar brain syndrome phase 2 with the exception of
  systemic hypotension (drug assisted),
  isoelectric EEG, absence of cerebral blood flow
  autonomic cardiac function
  spinal reflexes

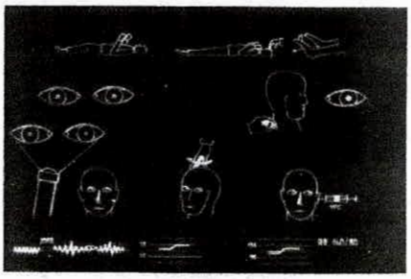
## Scheme of developement after severe brain damage



## Supratentorial volume increase



## Midbrain syndrome phase III



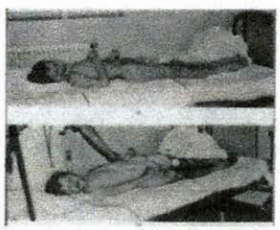
Phase III, Stretch-Flex position, disinhibition of autonomic system

## Midbrain syndrome phase IV

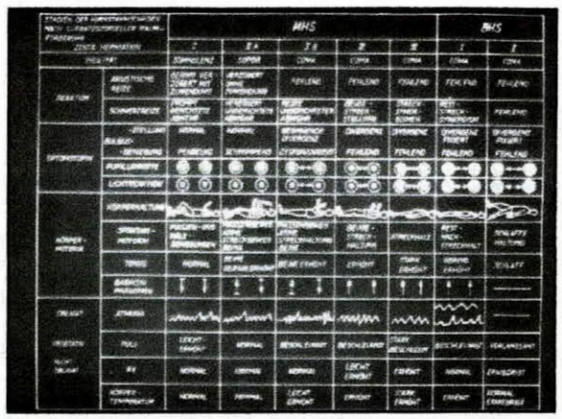
- Coma
- Missing blink reflex and ocular movements
- Divergent position of bulbi
- Pupils reduced reaction to light
- Vestibuloocular reflexes disturbed
- Stretch position of the extremities
- Increased muscle tone, pyramidal signs
- Respiration – machine like rythmus
- Hyperthermia, tachycardia, increased blood pressure

## Acute secondary midbrain syndrome

Traumatic brain injury, brain edema



Phase III, IV



### Prerequisites of Brain Death diagnoses, irreversible bulbar brain syndrome

- History of the patient:
- Aetiology of the pathological process:
  - brain trauma, encephalitis, haematoma (intracerebral, extracerebral)
  - brain edema, etc.
- Initial stage: continuing midbrain and bulbar brain dysregulations:
  - acute midbrain syndrome (4 phases and the full stage, stepwise disintegration)
  - acute bulbar brain syndrome (2 phases to final breakdown of all brain functions)
- Clinic of full stage of brain death:
  - Coma
  - brain functions, totally absent
  - brain stem functions, totally absent
  - apnea – respiratory arrest
  - vegetative dysregulations
- Additional examination:
  - EEG-isoelectric line
  - TCD-no cerebral blood flow (facultative)
- Other examinations in the initial phase:
  - Cerebral panangiograpy – no blood supply
  - Cerebral MRI-substantial lesions, signs of tentorial, foraminal herniation
  - MR-Angiography – no cerebral blood flow
  - Evoked potentials – no reaction

### Diagnostic program for brain death diagnoses, protocol

**First step**

1. History of patient
2. Clarification of the basic process
3. Neurological examination, monitoring, using checklist
   - initial stage
     - acute midbrain syndrome (phase 1 to 5)
     - acute bulbar brain syndrome (2 phases)
4. Additional examination-obligatory
   - EEG
5. Additonal examination – facultative
   - TCD
   - Neurosonology
   - Cerebral MRI, MR Angiographia
   - Cerebral CT
   - Evoked potential
   - Laboratory tests, CSF (if necessary)

**Second step**

Exclusion of all processes, possible to develop a reversible coma, a reversible bulbar brain syndrome phase 2

- hypothermia, exogenous
- hypoglycemia, hyperglycemia
- intoxication
- relaxation treatment
- metabolic derangement ( hepatic, renal etc.)
- hypoxia

**Third step**

1. Beginning of monitoring program
2. protocol with checklist for clinical symptoms
   - Coma
   - no response to external and internal stimuli
   - pupillary dysfunctions, totally
   - oculo-cephalic, vestibulo-ocular reflex
   - tracheal reflexes
   - apnea, after disconnection to the respirator - no spontanous breathing
   - blood gas rise in $PaCO_2$
3. EEG
4. TCD (facultative)

## Waiting period

- **Waiting period: 6 hours**
  - Clinical monitoring, check list
    - Recording every 2 hours
  - EEG, isoelectric line
    - Recording every 2 hours (30' recording time)
  - TCD (facultative) – no blood flow
    - Recording every 2 hours
- **Exclusion criteria for extension of waiting time to 12 hours**
  - Children
  - Hypothermia, exogenous (below 30°)
  - Acute intoxications (exogenous, endogenous)
  - Subarachnoidal haemorrhage
  - Hypoxemia (Hypovolemic shock)
  - Narcoses accidents
  - Surgical incidence
  - Relaxation treatment (Baclofen, etc.)
  - No certain aetiology
- **Reduced waiting period to 1 hour**
  - Penetrating head injury, gunshot
  - Severe open brain injury
  - Brainstem rupture
  - Cardiac arrest, without resuscitation
  - Brain tumour, inoperable, untreatable
  - Mass haemorrhage in the brain

## Brain Death - Team

- Neurologist - clinical monitoring
- Anaesthesiologist – responsible for ICU-care
- EEG-Specialist – responsible for EEG monitoring
- Excluded members of the transplantation team

## Russian criteria for Brain Death

*Approved by National Ministry of Health, April 2001.*

1. Clinical criteria: coma, no reaction on external and internal stimulation, absence of brainstem reflexes, dilated pupils, no response to bright lights, no ocular movements, no oculocephalic reflexes, no reactions to caloric testing, no tracheal reflexes, apnea, autonomic cardiac functions, no motoric functions of extremities and body, areflexia, no primitive motor patterns, no sensory - sensibility functions.
2. EEG – isoelectric line - in ICU little spikes can be accepted.
3. Apnoe test- negative (obligatory).
4. Cerebral angiographie - no circulation (obligatory only to reduce the waiting period).

## Minimal standard for brain death

- European preposition of brain death need highly qualified neurological service and modern equipment.
- In developing contries more interest to organize ICU, emergency rooms and intermediate care units saving lifes than to educate neurologists.
- Neurosurgery departments are avaliable replacing neurology.
- Internistic ICU are organised without neurologist
- Severe neurologic conditions are served without neurologist
- If brain death state is developing, minimal standards for diagnosis are necessary as an obligation of official neurological organisations (WFN, EFNS)

## Minimal standard of brain death diagnosis as proposed by the WFN Research Group Neuroethics

**Minimal standard of brain death, preposition of the WFN Research Group on Neuroethics**

Patients under the care of ICU, emergency room (ER), intermediate care (IMC) without neurologist and without EEG and TCD equipment but with an anesthetist or specially trained general practitioner responsible for the diagnosis

1. History of patients, in all details
2. Clarification of basic pathology, carefully
3. Exact diagnoses of the underlying acute disease
   - Traumatic brain injury
   - Encephalitis, different aetiology
   - Intracranial haematoma
   - Brain stem or brain infarct
   - Internal medicine diseases (cardial, etc.)
   - Surgical incidence
   - Narkosis accidence
4. Clinical course
   - Initial phase with acute midbrain and acute bulbar brain syndrome
5. Symptoms of brain death, full stage
   - Coma
   - No reaction to stimuli (external, internal)
   - sensory - sensibility functions, absent
   - No motor activities, including primitive motor patterns
   - Apnoe, demonstrable
   - Tracheal reflexes absent
   - Areflexia
   - Pupils maximal enlarged without reactions
   - Eye movements absent
   - Oculocephalic reflexes absent
   - No reaction to caloric testing
   - Systemic hypotension – drug assisted
   - Hypothermia – Poikilothermia
   - Autonomic cardiac functions
6. Use of existing diagnostic abilities and equipment
   - In optimal case EEG, recording the development of isoelectric line, without neurologist but by trained technical assistant
   - Evoked potentials, served by trained anaesthesist
   - TCD, served by trained anaesthesist
7. Waiting period 12 hours in any case
   - enlargement to 24 hours: children, intoxication, narcosis accident, metabolic coma
   - shortening depends to the primary brain damage
     - by existing EEG recording – isoelectric
     - by existing TCD – zero flow

## Minimal standard for brain death diagnosis

- Guidelines reflect the fact, in brain death diagnosis is only required for patients, that are in an ICU or are recieving life support in facilities such as emergency rooms and intermediate care and any artificial respiration support system (medical department, home respirator)
- Without this backup, patients in severe acute brain damage with respiratory insufficiency, malfunction of the artificial respiration system or in acute bulbar brain syndrome have no possibility to survive
- Natural death will occur with respiratory arrest followed by cardiac arrest

## Minimal standard for brain death diagnosis

- The objective of guidelines has to be focused to basic pathological process, the course of the disease with a clear definition of initial phase and its developement
- Dysfunction of brain stem with acute midbrain and acute bulbar brain syndrome
- Exact clinical diagnosis in the developement of the breakdown of whole brain functions
- Sufficiant waiting period including exceptions
- Employment of the existing diagnostic equipment
- Information of anaestesiologists, internists, general practitionars

## Management of brain death

- Activation in the education of neurologists
- Special training in pregrade and postgrade education system
- Organisation of neurological equipment (EEG, TCD, evoked potentials, MRI)
- Systemic training of neighbour specialities (neurosurgery, anestesiology)
- Brain death diagnosis without neurologist last but not least in the future is not acceptable by ethical reason