Brain death and organ donation

Lecture by
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Brain death = brainstem death
Steps of diagnosis

- Complete absence of brain activity
- Irreversibility
Complete absence of brain activity

- Clinical neurological signs
- Apnea test
- Vestibulo-ocular testing
- Other investigations:
  - EEG, EP, TCD, angiography
Clinical signs

- Pupil, light reactions
- Corneal reflex (V,VII)
- Trigeminal pain
- Auditory (vestib.) reaction
- Cough, suction
- Spontaneous breath

Doll’s eyes (FLM)
Apnea test

- Arterial cannul
- Breathing with FiO₂ 1,0 -10 min
- Disconnecting from the respirator, providing oxigen: 6 l /min.
- Undress the patient, check breathing movements
- Serial arterial blood gas measurements
- Brain death: pCO₂: 60 Hgmm or above, no spontaneous breathing activity
- Return to mechanical ventilation, donor management
Proving irreversibility

- Regular observation of all clinical signs
  - primary brain damage year 3- childhood-adulthood: 12 hours
  - secondary brain damage: 72 hours
  - 5 weeks- 3 years: 24 hours (both primary and secondary)
  - newborns: 72 hours

- OR: proven clinical signs + other tests
Cerebral angiography
Transcranial Doppler

TIME-COURSE OF FLOW VELOCITIES IN MCA FROM NORMAL CONDITION UP TO CEREBRAL CIRCULATORY ARREST

- normal
- decreasing diastole
- systolic peaks

- increasing ICP
- decreasing CCP
- decreasing vascular bed
BAEP
BIS index
Indications for brain death diagnosis

• Organ donation

• Verifying death in critically ill patients—stopping further intensive therapy
Donor

• **Living donor**
  - kidney
  - bone marrow
  - liver
  - cutis

• **Cadaver donor**
  - kidney
  - liver
  - pancreas
  - heart
  - lung
Responsibilities of the IC

• Diagnosis of brain death, intensive therapy
• Verifying donors
• Proving brain death (committee)
• Organ preservation
Potential donor

- The actual condition of the patient predisposes to brain death
- Frequent causes:
  - isolated head trauma,
  - intracranial bleeding
  - primary brain tumor
  - cerebral anoxic damage
Conditions not suitable for donation

- Patient refused donation
- Medical causes
  - malignancy
  - sepsis
  - infectious disease (HIV, Tbc)
  - metabolic coma
  - intoxication
  - muscle relaxation
  - hypothermia
  - mechanical ventilation for more than 7 days (?)
Organ-specific points:

**kidney 1.**

- **Criteria:**
  - age: 4-70 years
  - maintained circulation

- **Contraindications:**
  - known kidney disease
  - kidney trauma
  - hypotension for more than 1 hour (below 60 mmHg)
  - proteinuria of kidney origin
  - Kreatinin > 300 umol/l
• Relative contraindications
  – severe hypertension (3 combination)
  – severe, long-lasting insulin-dependent diabetes
• Diagnostic tests:
  – KN
  – creatinin
  – urine
• Others: abdominal US, chest X-ray, serological assessments
Organ-specific points: liver 1.

- **Criteria:**
  - age: 2-60
  - maintained circulation

- **Contraindications:**
  - Known liver disease
  - alcohol, drog-abuse
  - hepatotoxic drugs
  - liver damage
  - abdominal infection
  - long lasting hypernatremia (Na: higher than 170 mmol/l)
  - Long lasting respirator therapy
  - severe obesity
Organ-specific points: liver 2

• Diagnostic tests:
  – liver functions: Se Bilirubin, GOT, GPT, gamma GT, AP,
  – prothrombin
  – urine bilirubin, ubg
  – serum albumin
  – serology: HIV 1-2, HBsAg, Hepatitis C, CMV

• Other: abdominal US
Organ-specific points: heart 1.

- **Criteria:**
  - age: below 45
  - maintained circulation

- **Contraindications:**
  - known cardiac disease (valvular lesion, CMP, congenital, coronary artery)
  - severe hypertension
  - heart trauma or damage
  - chatecholamine in high dose (10 ug/kg/min or more)
  - long-lasting mechanical ventilation (7 days)
  - long lasting hypotension
Organ-specific points: heart 2.

- **Diagnostic tests:**
  - serology: HIV 1-2, Hepatitis C, CMV
  - auscultation
  - 12 lead EKG
  - BP
  - pulse rate,
  - CVP
  - chest X-ray

- **Others:** CK, CK-MB, LDH, echocardiography, chest X-ray
Organ-specific points: lung 1.

- Criteria
  - Age below 65
  - maintained circulation
  - ventilation: FiO2 below 40 %
  - PEEP: below 5 water cm
  - normal blood gases
Organ-specific points: lung 2.

- **Exclusion criteria:**
  - known pulmonary disease (tbc. asthma)
  - smoking history (?)
  - severe thoracic trauma
  - infection
  - aspiration
  - severe atelectasis
  - high arterio-alveolar oxygen gradient
    - FiO2 = 1
    - PEEP = 5 water cm
    - artérial oxygen below 350 mmHgmm
  - ventilation with high plateau pressure (30 water cm or more)
Organ-specific points: lung 3.

- **Diagnostic tests**
  - Standardized chest X-ray:
    - focus- film=1 m
    - vertical distance: two lateral sinuses
    - horizontal distance: upper pole of the diaphragm and apex
  - bakteriology
  - bronchoscopy
  - FiO2 40%, PEEP 5 water cm: blood gases are normal after 15 minutes mechanical ventilation
  - FiO2 100%, PEEP 5 water cm: blood gases after 15 minutes:
    - normal: arterial oxigen higher than 350 mmHg
    - not suitable for donation: O2 below 350 mmHg
Organ-specific points: pancreas 1.

• Criteria:
  – Age below 50
  – maintained circulation

• Contraindications:
  – pancreatitis
  – diabetes mellitus
  – abdominal infection
  – Long lasting hypotension
  – Alkohol, iv. drog
  – Ion
Organ-specific points: pancreas 2.

- **Clinical tests**
  - serum and urine amylase
  - blood glucose
  - abdominal US
General tasks

• Monitoring: invasíve, non invasíve BP, SpO2, ETCO2, temperature, diuresis, laboratory tests, invasive hemodynamic monitoring.

• Care: decubitus, aspiration, pneumonia, sepsis prophylaxis, hypothermia
Special problems

- Hemodynamic disturbances
- Metabolic disturbances
- Mechanical ventilation
- Hemostasis alterations
- Infections
Haemodynamic disturbances

- Hypovolemia
- Myocardial ischaemia
- Thermoregulation disturbance
- Endocrine dysfunction
- Metabolic disturbances
Causes of hypovolaemia

- Systemic vasodilation (sympathicolysis)
- Diabetes insipidus
- Hyperglycemia
- Bleeding (polytrauma)
- Inappropriate volumen therapy
Treatment of hypovolemia

• Monitoring:
  – invasive BP
  – CVP
  – pulse
  – diuresis
  – hemodynamic monitoring

• Treatment:
  – Volume:
    • electrolyte solutions
    • plasma expander
    • Mg, P, Ca, K
  – transfusion
Hypovolemia: goals of treatment

- MAP 65 mmHg or above
- Cardiac index: 2.1 l/min
- PCWP: 12-15 mmHg
- CVP: 12 mmHg
- Diuresis: 100 ml/h or above
- Arterial O2 (PaO₂): 100 Hgmm or above
Diabetes insipidus

- 80%
- Cause: decreased ADH production
- Monitoring:
  - diuresis (300 ml/h or above)
  - urine special gravity, osmolarity decreases
  - serum osmolarity increases
  - Serum Na increases
  - Urine Na remains unaltered
  - CVP decreases
- Treatment: substitution (pitressin, desmopressin) + fluid therapy
Myocardial ischemia

- Hypertension (catecholemin-storm): beta-blockers
- Bradyarrhythmia: atropin ineffective, catecholamin (dobutamin)
- Supraventricular and ventricularis tachycardia: beta-blocker or antiarrythmics
- Hypotensio: catecholamine, volume therapy, treatment of diabetes insipidus
Thermoregulatory disturbances

• **Causes:**
  – damage of thermoregulatory center
  – peripheral vasoparalysis
  – cold infusions
  – low environmental temperature

• **Goal:** normothermia

• passive warming, warmed infusions
Endocrine disturbances

- Hyperglycemia: insulin
- Diabetes insipidus: desmopressin, pitressin
- Decrease in T3: levothyroxin (20 ug bolus, than 10 ug/h)
- Suprarenal gland:
  - Cortisol decreases: Methylprednisolon 15 mg/kgbw
  - Epinephrin 1-5 ug/min
Metabolic disturbances

• **Hypernatremia**
  – cause: diabetes insipidus, diureticum
  – Th: isotonic saline, 5% glucose, spironolacton, substitution

• **Hypokalaemia, hypomagnesaemia, hypophosphataemia**
  – cause: volume loss

• **Hypocalcaemia**
  – Cause: acute tubular necrosis, insufficient intake, CPD-conserved blood product
  – Th: Calcium-chloride
Mechanical ventilation

- **Goals:**
  - pH = 7.4
  - SpO2 > 95%
  - Tidal volume: 8-10 ml/ kg
  - FiO2 < 40%
  - PEEP < 7 wcm
  - normocapnia
  - inspir. Plateu pressure: below 20 wcm
Hemostasis

• Risk of DIC
• Goals of therapy:
  – Hgb 100 g/l or above
  – Thr: 30 000 or above
  – normothermia
Antibiotic prophylaxis

- **Non lung donor:** Cefuroxim or Cefazolin or amoxicillin+clavulan
- **Lung donor:** previous+antibiotics based on sputum culture
Haemodynamic:
- colloid
- adrenerg dysregulation: norepinephrin

Metabolic:
- lack on thyroid hormone
- desmopressin +++
- normothermia

Respiratory:
- normoxaemia

Hemostasis:
- DIC diagnosis and treatment

Infection control:
- culture (bakterium, fungal)
- antibiotic prophylaxis

Quality of the transplanted organ