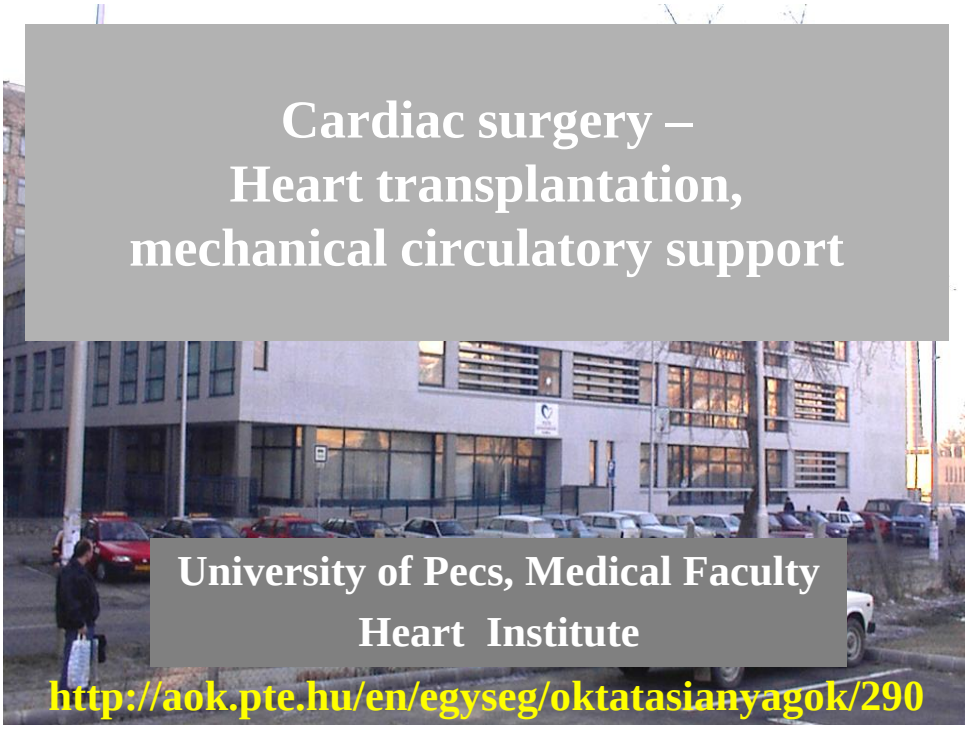
Cardiac surgery – Heart transplantation, mechanical circulatory support



University of Pecs, Medical Faculty

Heart Institute

http://aok.pte.hu/en/egyseg/oktatasianyagok/290

Treatment for heart failure

Medical:
inotrops, digitalis, diuretics, beta-blocker...

CRT, multisite pacing

Conventional surgical or interventional treatment of CAD, valvular disease

Acute mechanical circulatory support (<2 weeks)

Permanent mechanical circulatory support (>2 weeks) „bridge to transplantation", „bridge to recovery", „bridge to bridge", „destination therapy"

Heart transplantation

Mechanical circulatory support

<u>Indication:</u> serious reversible or irreversible heart failure in spite of maximal medical therapy

<u>Aims:</u>

Reversible: 1. assuring adequate tissue perfusion
2. unloading the heart until recovery

Irreversible: assuring adequate perfusion until HTX

Short range (<2 weeks) ⟷ Long-range (>2 weeks)

Extracorporal ⟷ Intracorporal

TAH ⟷ VAD (LVAD, RVAD, BiVAD)

Pulsatile ⟷ Continuous flow

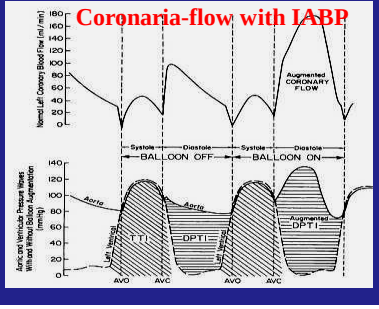
(TAH – total artificial heart, VAD – ventricular assist device)

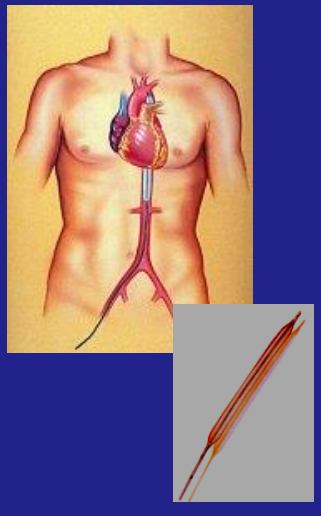
Acute mechanical circulatory support

<u>Intraaortic balloon pump</u> (IABP)

- failure of inotropic treatment
- threatening! cardiogenic shock

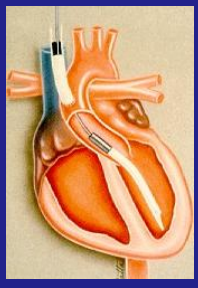
➢ improving coronary perfusion
➢ (reducing afterload)





Acute mechanical circulatory support

Hemopump



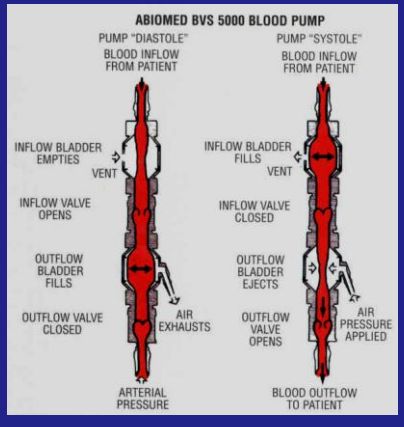
Hemopump device inserted into the left ventricle through the ascending aorta and the portable control unit.

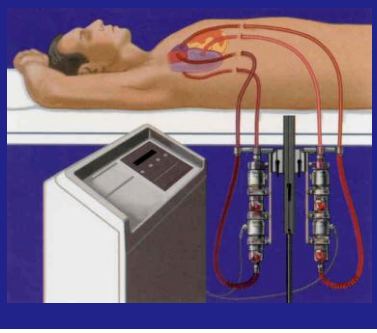
The 24-Fr version is capable to maintain the total minute volume, therefore the heart can be arrested medically without the background of ECC.

Acute mechanical circulatory support

Abiomed BVS 5000

Univentricular or biventricular assist.





Mechanical circulatory support

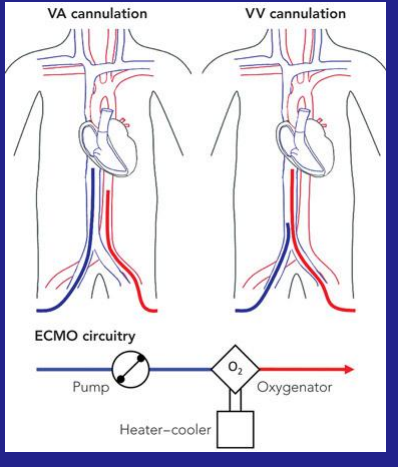
Pulsatile flow, paracorporal, mid-term

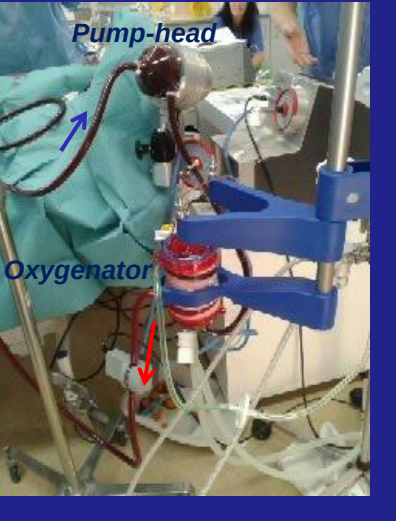
RVAD LVAD
BiVAD

MEDOS Medizintechnik AG

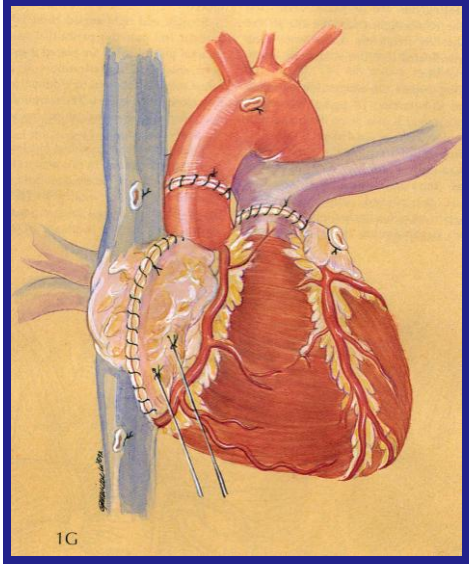
ECMO – extracorporal membrane oxygenator

Respiratory, cardiorespiratory insufficiency





The evolution of HTX



1905. Carrel, Guthrie
vascular suture, organ tx
1960. Lower, Shumway
present technique, cooling
1964. Hardy et al.
chimpanzee heart to human
1967. Barnard
human to human
1980s
cyclosporin

Admission to the HTX program

Indications:

- **NYHA IV in spite of maximal iv inotrop therapy**
- **Max. VO2 < 10ml/kg/min (<14, relative indic.)**
- **syncope, ventricular ectopies**
- **bad quality of life, complaints limiting everyday activity**
- **high risk for cardiac mortality within 1 year**

Contraindications:

- **> 60-65 years**
- **active infection, or GI ulcer, diabetes mellitus, serious peripheral vascular disease, pulmonary disease, malignancy**
- **elevated pulmonary vascular resistance (>5 Wood, >3.5 rel)**
- **psychical instability, alcohol or drug abuse**
- **loss of compliance, impossible follow-up**

Donor selection

- brain death
- matching ABO with the recipient
- age less than 40-45 years
- similar body weight (size) to the recipient
- loss of cardiovascular disease
- loss of pulmonary disease
- no malignancy (except brain tumor)
- no infection (HIV, CMV, Hepatitis)
- no sepsis
- expected ischemic time < 4-6 hours

Immunosuppression after HTX

- MMF (mycophenolate mofetil, *Cellcept*)
- tacrolimus (calcineurine inhibitor)
- corticosteroid (prednisolone)
- /cyclosporine (earlier)/

Rejection:

- corticosteroid
- ATG (anti-thymocyte-globuline)
- ALG (anti-lymphocyte-globuline)

Regular endomyocardial biopsy

Special complications of HTX

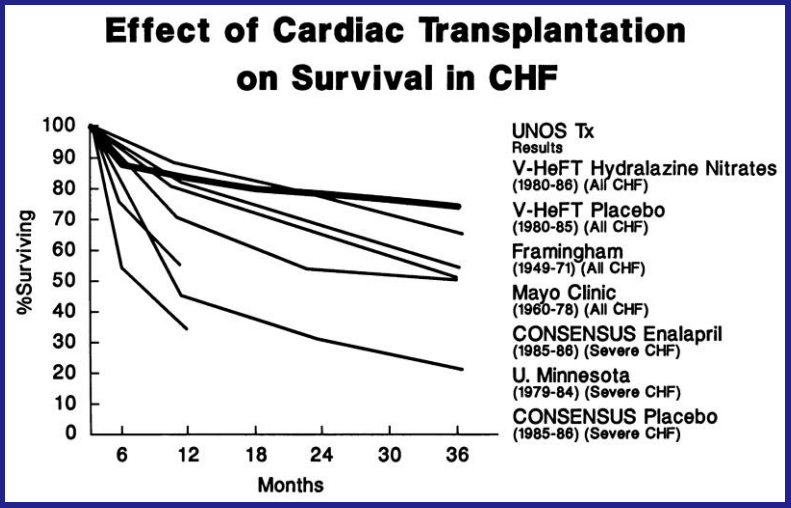
- infection (transmission, susceptibility)
- rejection
- graft coronariasclerosis
- secondary malignancies (lymphomas)
- nefrotoxicity (of cyclosporin)
- death

Problems of HTX

- complications → new immunosuppressives
- donor shortage → networks (UNOS, Eurotransplant), alternatives
- ethical concerns (abating)
- legal concerns (abating) (definition of brain death, need for consent)
- expenses

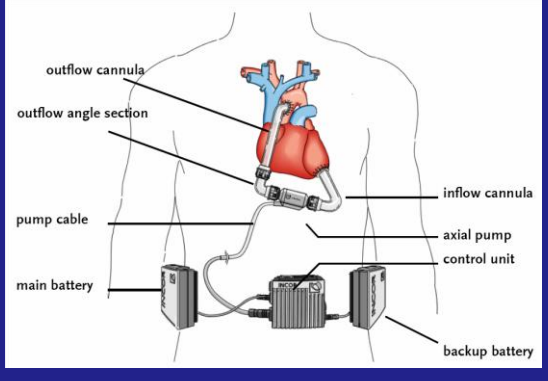
90 % one-year and 50 % 10-year survival, annually about 3500 HTX all over the word, whereas emerging need for several ten-thousand

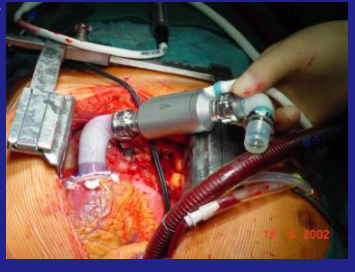
Comparing survival after HTX or medical treatment

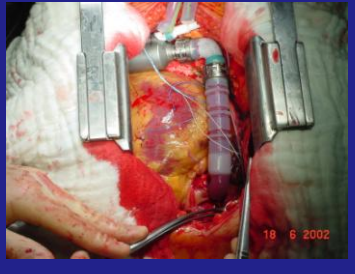


Berlin Heart Incor (LVAD)

- **Intracorporal, continuous flow, permanent**
- **INR: 2,8-3,2**
- **APTI: 70-90 s**
- **Efficient anti-TCT therapy**

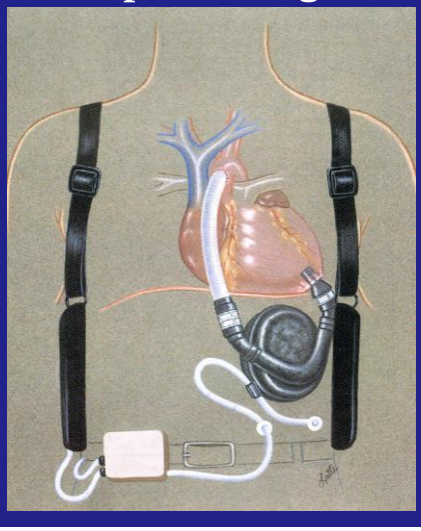


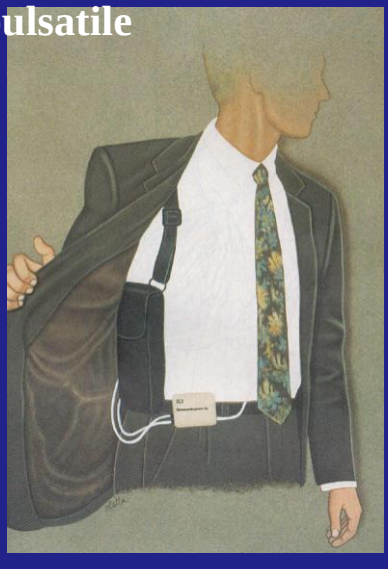




Mechanical circulatory support - Univentricular assist

Intracorporal, long-term, pulsatile





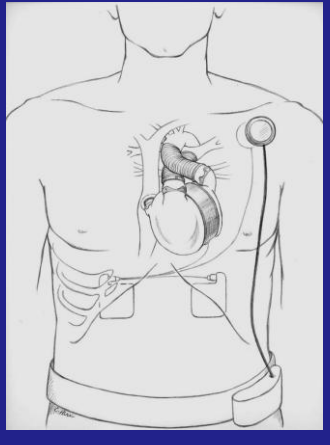
Mechanical circulatory support - Univentricular assist

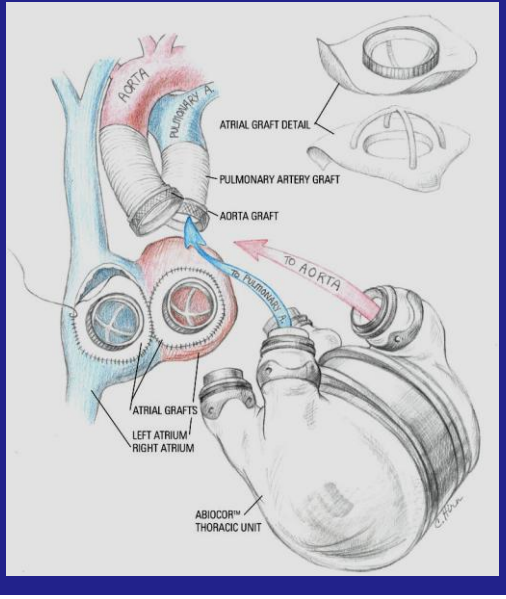
1963. M. DeBakey – first human application

Draining blood from the apex of the left ventricle, pumped into the ascending or descending aorta. (applicable also in the right heart)
Since the 80s mainly in the US several hundred devices were implanted as a bridge to transplantation. Recognized the reverse remodeling as an effect of unloading the heart. Many patients were removed from HTX program because of their improvement. The future?

Artificial heart – the Abiocor

Artificial heart – the Abiocor





Artificial heart, xenotransplantation

Artificial heart: human application in experimental phase

1959. S. H. Norton, T. Akutsu, W. Kolff

1969. D. A. Cooley (Liotta pneumatic heart) as a bridge to transplantation

1982. DeVries (Jarvik-7) as a final therapy

***Now:* Texas (Abiocor), Cleveland, Pittsburg**

***Problems:* thromboembolism, power supply, safety of operation, infection, haemolysis, adaptation to needs**

Xenotransplantation: animal experiments (swine)
Preventing rejection with modified surface antigenes

Future possibilities

Molecular cardiomyoplasty: Fibroblasts in the infarction scar are "infected" with MyoD-gene resulted in muscular differentiation.

Cellular cardiomyoplasty: infiltrating the scar with myoblasts (satellite-cells) or stem cells from skeletal muscle, those can differentiate into heart muscle

Embryonal correction of the gene responsible for the cardiomyopathy

Induction of angioneogenesis by growth factors

Summary

- HTX – gold standard
- Efficient mechanical circulatory support avail.
- The timing of mechanical assist is crucial !
- Choosing the appropriate device (availabilities)
- Bridge to HTX reduces mortality and costs
- Fast technical development – future ?
- Expenses