

# The substitution of renal function

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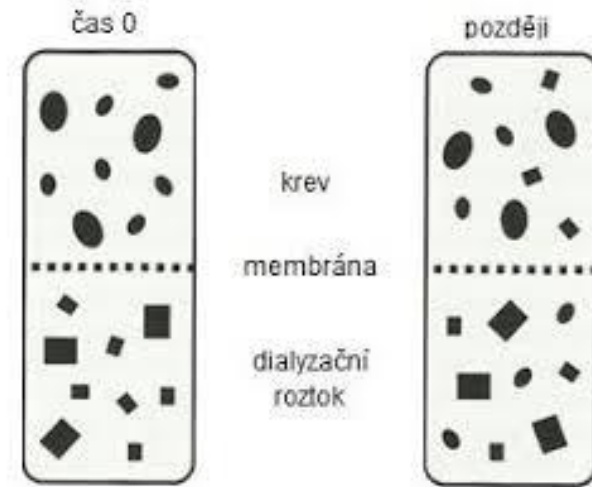
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# Summary:

- ▶ Intermittent methods:
  - ▶ Longterm substitution
  - ▶ Usually managed in intervals (e.g.: 3x per week for 5 hours, in case chronic renal failure)
- ▶ Continual methods:
  - ▶ Only temporary substitution
  - ▶ Without interruption, for patient in critical state

# Hemodialysis

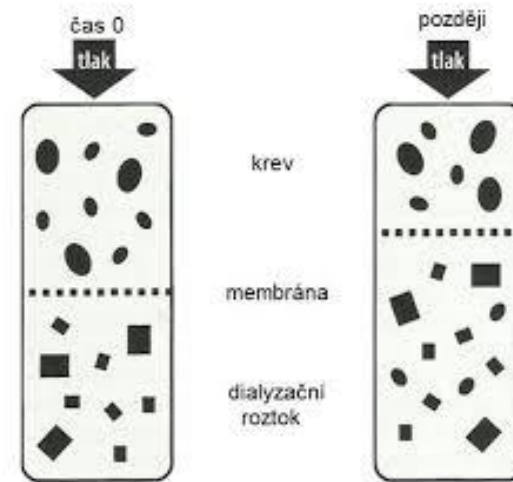
- The most frequent used principle
- Blood is pumped from vessels to extracorporeal circulating system
- Here is in touch with hemodialytic liquid
- The main principle of this technique is diffusion
- Exchange of hemodialytic liquid is required
- It is better for reduction of low-molecular weight matters from blood



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# Hemofiltration

- The main principle of this technique is filtration
- Blood with its pressure is transported to semi-permeable membrane
- We have to substitute the loss of liquid from blood during this technique
- It is better to reduce high-molecular weight matters
- Unlike hemodialysis, it isn't connected with hypotension
- This method simulates glomerules



[https://encrypted-tbn0.gstatic.com/images?q=tbn:ANd9GcT3TlxyESVOxivaSvF1IE-vEad\\_MxX\\_bGxrYnVLz6BGHmaLkmtuEQ](https://encrypted-tbn0.gstatic.com/images?q=tbn:ANd9GcT3TlxyESVOxivaSvF1IE-vEad_MxX_bGxrYnVLz6BGHmaLkmtuEQ)

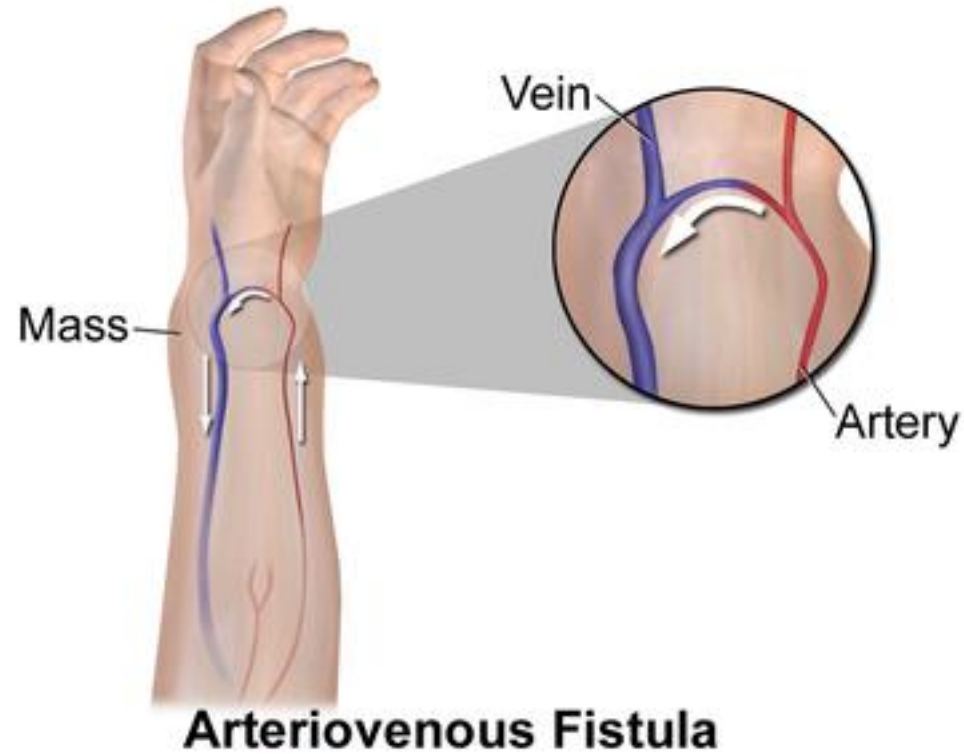
# Hemodiafiltration

- ▶ The combination of hemodialysis and hemofiltration
- ▶ We can reduce wide spectrum of metabolites
- ▶ Difuse part is the same as in hemodialysis
- ▶ Filtration part is reduced than in hemofiltration
- ▶ Also we have to substitute the loss of liquid during this process

# Vascular access

- ▶ For long-term hemodialysis we need good stable vessel access
- ▶ These requirements is covered only by chirurgical A-V shunt
- ▶ Usually radiocephalic shunt is used
- ▶ Shunt requires time to become ready for dialysis
  - ▶ We shouldn't work with it when the local infection is present
  - ▶ It should be palpable subcutaneously
- ▶ The alternative is arteficial material, but it has more complications

# A-V shunt



[https://upload.wikimedia.org/wikipedia/commons/thumb/f/fd/Blausen\\_0049\\_ArteriovenousFistula.png/400px-Blausen\\_0049\\_ArteriovenousFistula.png](https://upload.wikimedia.org/wikipedia/commons/thumb/f/fd/Blausen_0049_ArteriovenousFistula.png/400px-Blausen_0049_ArteriovenousFistula.png)

# Vascular access catheter

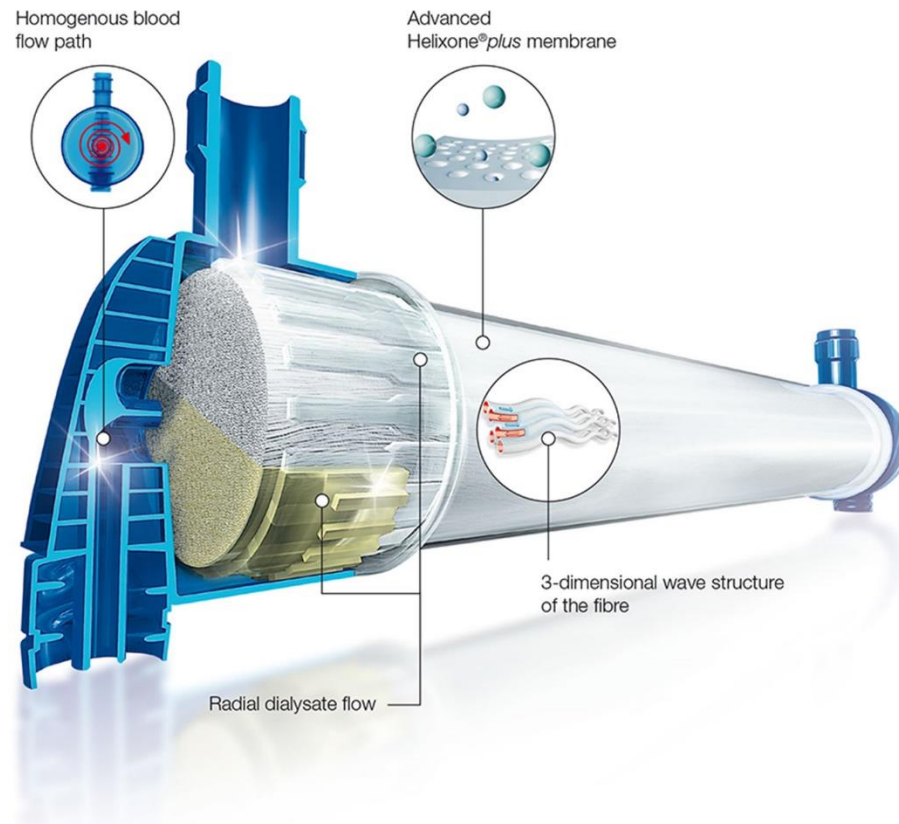
- ▶ Temporary acces until A-V shunt is prepared
- ▶ It is time limited for 3 weeks, after that the lumen could be trombotised, the efficiency is rapidly reduced
- ▶ *If we have patient who will need hemodialysis, we should save his vessels to A-V shunt.*



# Dialyzer a filter

- ▶ Today, we use capillary dialyzers, which substitute board ones
  - ▶ Blood is flowing in capillars surrounded by dialysing liquid
- ▶ The trend is to make dialyzer with more biocompatibility
- ▶ Dialyzer in Czech republic is used only once vs USA
- ▶ The most important part is the dialysis membrane
  - ▶ In past we use celulosis to create membranes, today we prefer modified celulosis or syntetic materials

# Capilar dialyzer



[https://www.freseniusmedicalcare.cz/fileadmin/data/masterContent/images/Healthcare\\_Professionals/01\\_Hemodialysis/Dialysers/FX\\_CorDiax/BAS020\\_FXClass-dialyzer.jpg](https://www.freseniusmedicalcare.cz/fileadmin/data/masterContent/images/Healthcare_Professionals/01_Hemodialysis/Dialysers/FX_CorDiax/BAS020_FXClass-dialyzer.jpg)

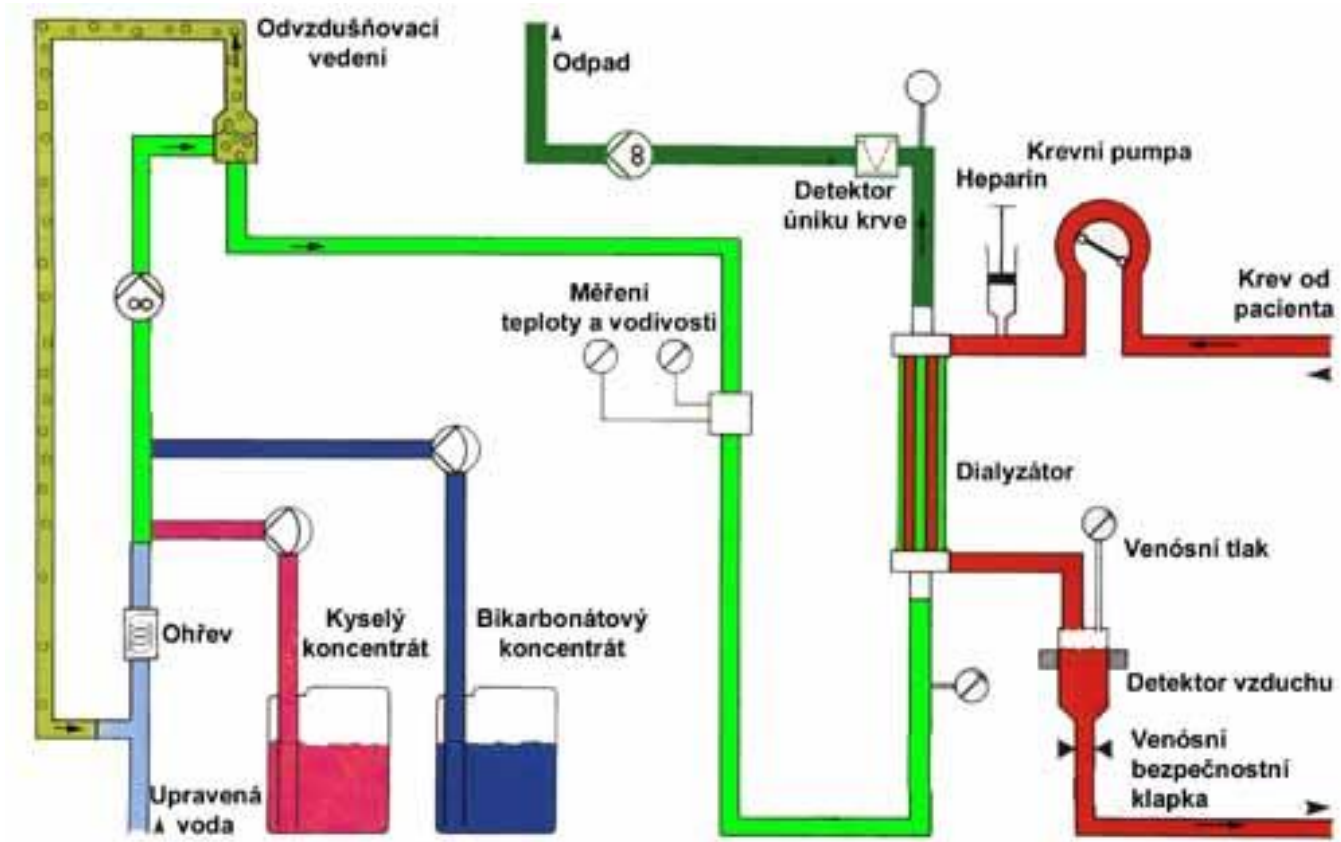
# Biocompatibility

- ▶ Membranes and other parts of machine aren't perfectly biocompatible
- ▶ It has many complications:
  - ▶ Trombogenicity:, use LMW heparines before procedure, or put citrate to the machine
    - ▶ Pay attention if patient has coagulopathy
  - ▶ Activation of complement due to arteficial membranes could damage patinet's blood cells
  - ▶ Other complication is leucopenia, activated complement could sequestrate leukocytes in pulmonary blood vessels

# Dialyzer monitor

- ▶ Machine, where hemodialysis is situated
- ▶ It is equipped with hemopump
- ▶ It can measure pressure or recognize gas in vessel
- ▶ It is also equipped with blood detector, which could detect blood in the machine
- ▶ Machine keeps the blood warm
- ▶ An important part is the dialysing liquid

# The diagram of hemodialyzer



<http://www.inmed.cz/obrazky/schema.jpg>

# Hemodialyzer - monitor



[http://www.kzcr.eu/rop/data/gallery/8/big/DC\\_ROP\\_28.jpg](http://www.kzcr.eu/rop/data/gallery/8/big/DC_ROP_28.jpg)

# Indications and contraindications

- ▶ Chronic renal failure
  - ▶ All patients, where conservative treatment fails
  - ▶ We don't start treatment in case that patient refuses it
  - ▶ We can't chose this hemodialysis when patient is circulatory unstable and doesn't have vessel access
  - ▶ If it isn't contraindicated, we should follow patient wish
  - ▶ Hemodiafiltration or hemofiltration should be preferred in patients with long-term substitution of renal function
    - ▶ It has lower risk of amyloidosis

# Indications

- ▶ Acute renal failure
  - ▶ Usually potentially reversible state
  - ▶ We prefer hemofiltration to reduce high-molecular matters, which are connected to etiology of this disease
  - ▶ It is used when conservative therapy fails
- ▶ Next indication is poison of dialysable matters (e.g.: Li, ethylenglycol, methanolum)



# Frequention of hemodialysis

- ▶ Patients with chronic renal failure attend 3 times per week
- ▶ One procedure takes around 3-5 hours
- ▶ We have also variant of continual hemodialsysis
  - ▶ Every day for 2 hours
  - ▶ Or 8-10 hours at night
  - ▶ We have limited experiences with these methods

# Complications

- ▶ Divided in acute or chronic
- ▶ Acuted is attached for one procedure
- ▶ Chronic are created in longer period and persists for longer time
- ▶ Patients using hemodialysis are polymorbid, it is difficult to recognize complications from basal diseases

# Acute complications

- ▶ Bleeding
  - ▶ Patients have problems with uremic coagulopathy or usage of heparines
- ▶ Blod clotting in hemodialyzer
- ▶ Hypotension
  - ▶ Due to the liquid loss from blood in dialyzer
  - ▶ It is bad perceived by patients, they have nauzeu, vommiting.
- ▶ Hypertonic reaction
  - ▶ Excessive reaction of body to liquid loss, we should use vasodilatators
- ▶ Anafylactoid rection
  - ▶ Due to bad compability of biomembranes in hemodialyzer
- ▶ Gas embolization

# Chronic complications

- ▶ Dialyzating amyloidosis
  - ▶ Storage of  $\beta_2$ -mikroglobulines, it causes carpal tunel syndrome, artropathy, artritis
- ▶ Malnutrition
  - ▶ It could happen that nutritient move to dialyzating liquid
- ▶ Imunity decrease
  - ▶ We speculate that long-term hemodialysis could inactivate monocytes
- ▶ Atherosclerosis
  - ▶ We think that dialysis causes chronic inflamation which facilites atherosclerosis

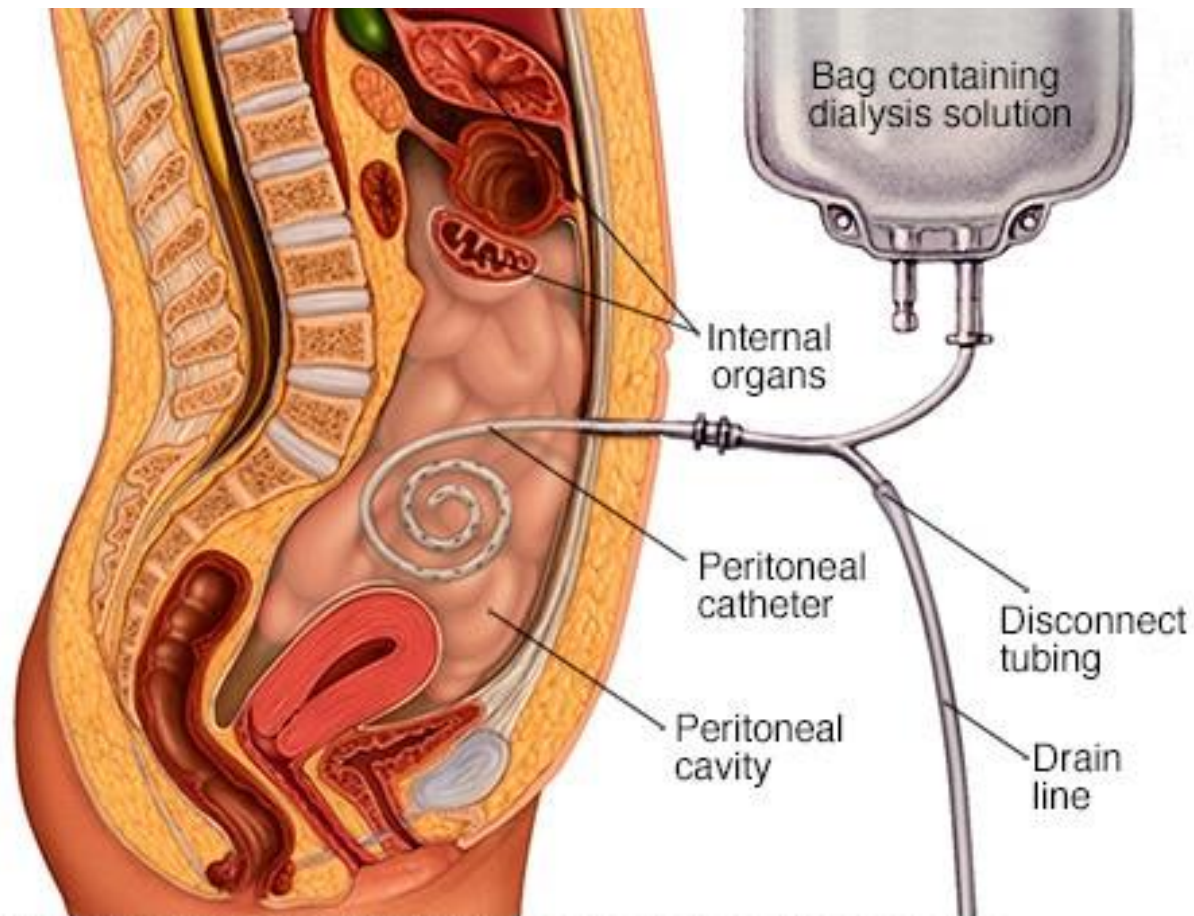
# Continual substitution of renal function

- ▶ Effective in patients with acute renal failure
- ▶ Principles are similar to intermittent methods
- ▶ Advantage of this method is continuous elimination of toxic metabolites
- ▶ We also continuously eliminate nutrients from blood, so patient is vulnerable to malnutrition
- ▶ Longer contact with biomembranes increase problems with biocompatibility
- ▶ Different surveys show that there is no difference in effectiveness between intermittent and continual methods in patients with acute renal failure

# Peritoneal dialysis

- ▶ We apply hemodialytic liquid to intrabdominal space for continuous dialysis
  - ▶ We have to exchange the liquid 3-5 times per day
  - ▶ It is more similar to the renal function
  - ▶ We have to put a peritoneal catheter
- ▶ Usually it is used as an alternative for conventional hemodialysis
  - ▶ In the Czech Republic we use this method in 10% of cases, usually for patients with chronic renal failure

# Peritoneal dialysis- diagram



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<https://www.mayoclinic.org/-/media/3df03453c80f4a81b00319df007399b1.jpg>

# Advantages and disadvantages of peritoneal dialysis

## ▶ Advantages:

- ▶ We could do it regularly in ambulance
- ▶ The character of body liquid isn't oscillating too much
- ▶ We could save blood vessel asses for future use of hemodialysis

## ▶ Disadvantages:

- ▶ Peritoneal infection
- ▶ Endogenous loss of protein to dialyzator
- ▶ Excess of glucose income from dilyzating liquid



# Indications a contraindications

## ▶ Indications

- ▶ Analogical as in hemodialysis
- ▶ Patient preferences
- ▶ Absolute indication is inability to make vascular acces

## ▶ Contraindications

- ▶ Adhesions in abdominal cavity
- ▶ Carcinomatosis of peritoneum
- ▶ Active intestinal infection
- ▶ Colostomy, nephrostomy
- ▶ Polycystic kidneys

# Complications

- ▶ Infectious
  - ▶ Local infection
  - ▶ Tunnel infection
  - ▶ Peritonitis
- ▶ Noninfectious
  - ▶ Catheter damage
  - ▶ Extracorporeal leakage
  - ▶ Hernia due to the higher intraabdominal pressure
  - ▶ The damage of peritoneal filtration function

# The end

- ▶ Resources:

- ▶ TESAŘ, Vladimír a Ondřej VIKLICKÝ. *Klinická nefrologie / Vladimír Tesař, Ondřej Viklický editoři*. 2015. ISBN 9788024743677.