Dialysis & Renal Transplantation

Prof Madunil A Niriella

Department of Medicine

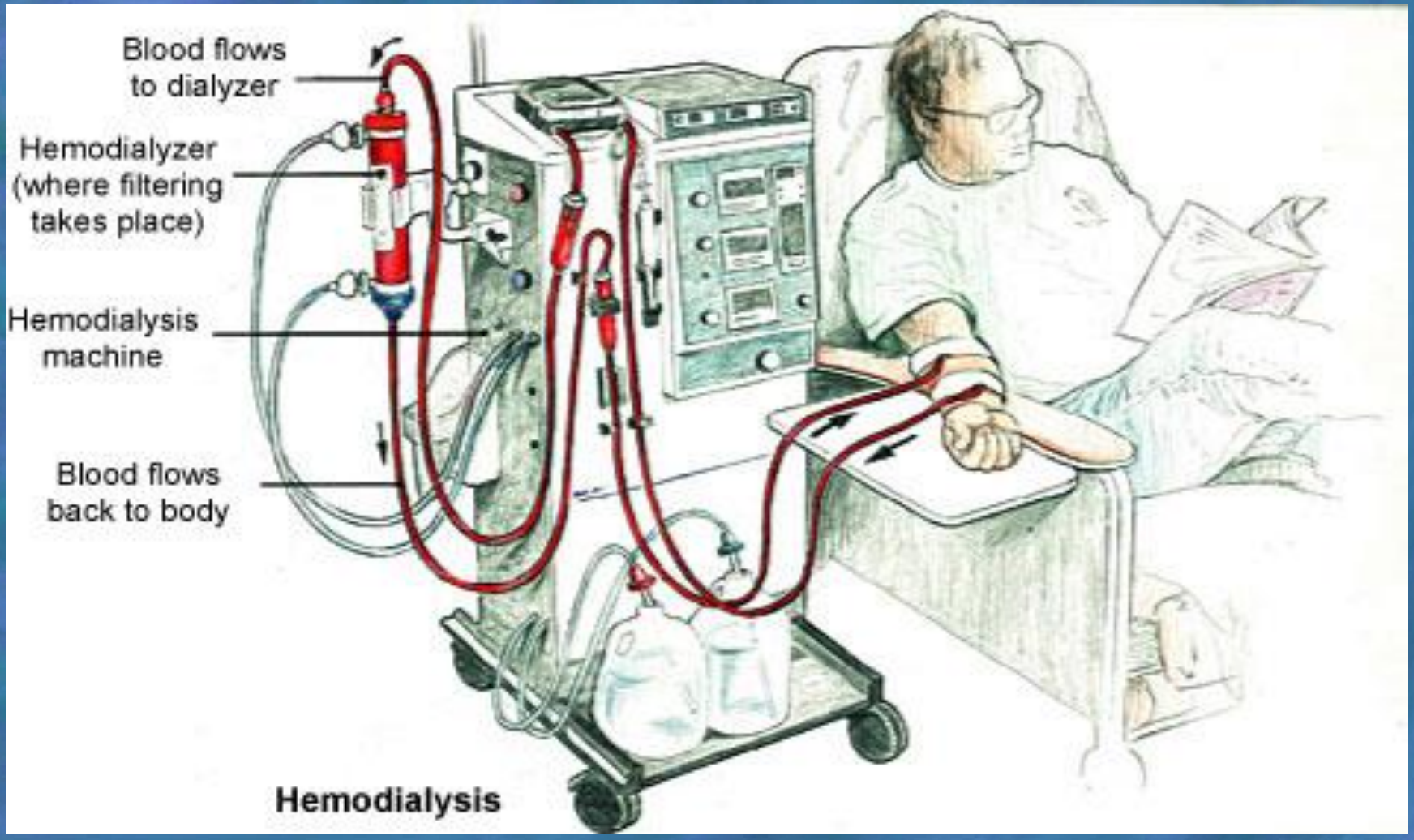
Management Options in End Stage Kidney Disease (ESKD)

- Haemodialysis (HD)
- Peritoneal Dialysis (PD)
- Renal Transplantation (Tx)
- Conservative Management

Principles of HD

- Blood from patient pumped through dialyser ('artificial kidney')
- Dialyzer → series of semi-permeable membranes (usually cellulose-based)
- Dialysate flows within dialyzer, counter-current to blood flow
- Plasma biochemistry changes to that of dialysate → molecules diffuse down concentration gradients

Haemodialysis

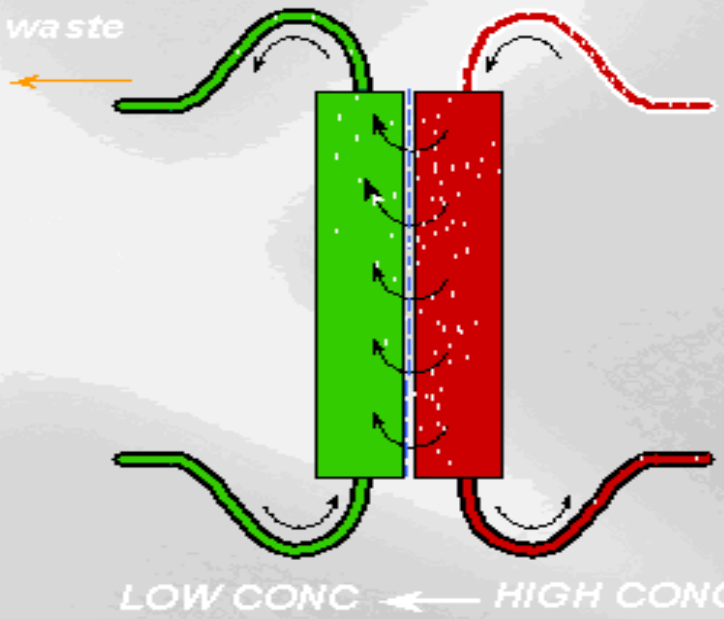


Principles of HD

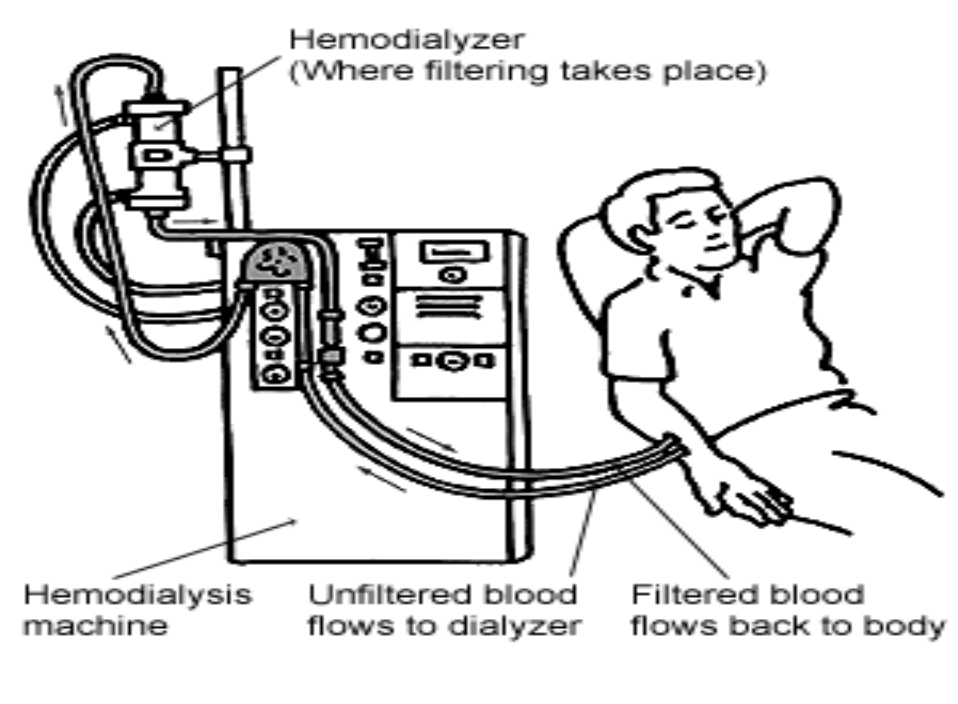
prismaflex

Hemodialysis

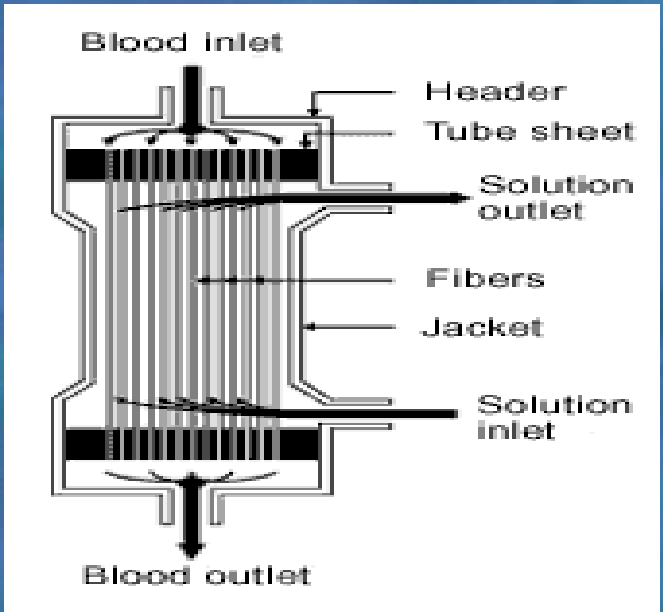
Movement of small solutes by diffusion through the addition of dialysate to the fluid side of the filter.

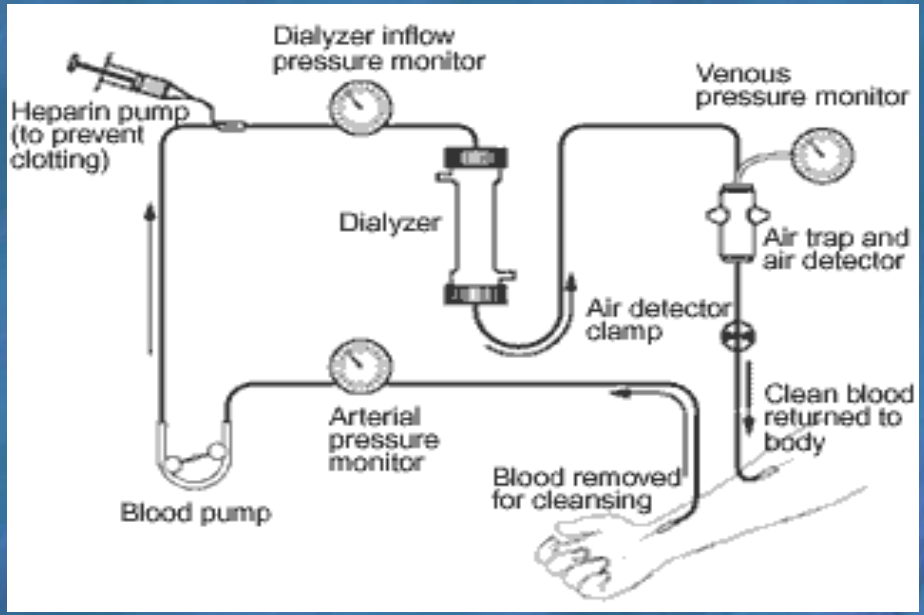


GAMBRO Renal Products


Hemodialyzer
(Where filtering takes place)
Hemodialysis machine
Unfiltered blood flows to dialyzer
Filtered blood flows back to body

Dialyzer


Blood inlet
Header
Tube sheet
Solution outlet
Fibers
Jacket
Solution inlet
Blood outlet

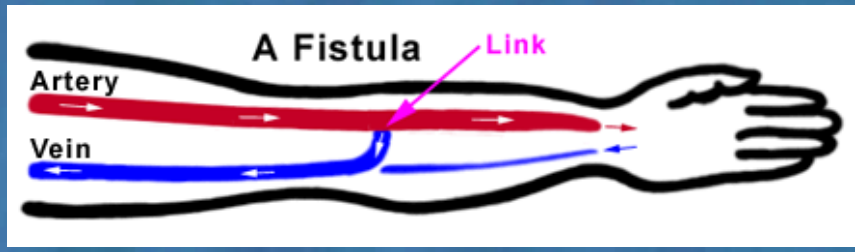

Dialyzer inflow pressure monitor
Heparin pump (to prevent clotting)
Venous pressure monitor
Dialyzer
Air trap and air detector
Air detector clamp
Clean blood returned to body
Arterial pressure monitor
Blood removed for cleansing
Blood pump

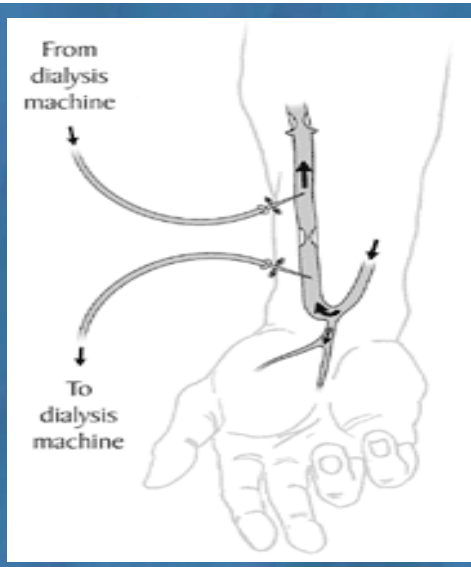
Access for HD

- Arterio-venous fistula (AVF)
- Arterio-venous shunts
- Dialysis catheters

Arterio-Venous Fistula

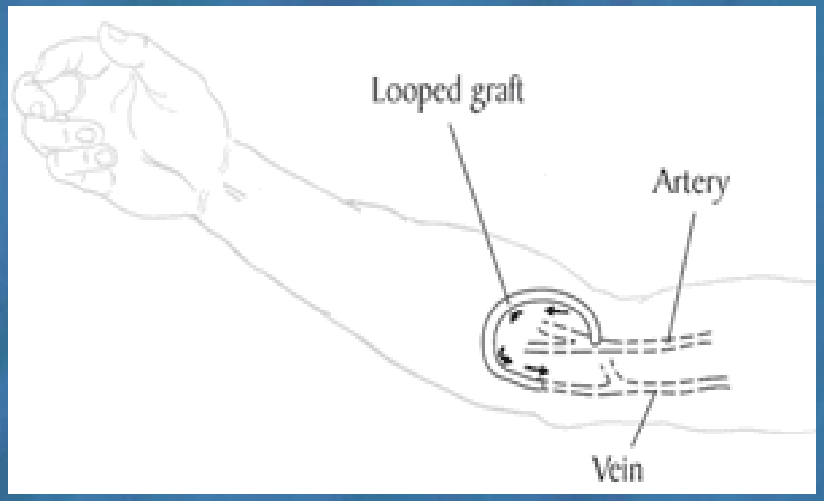
- Radial / brachial artery & cephalic vein
- Connected surgically
- Takes 6-8 weeks to mature
- Large bore needles inserted to take blood to & from dialysis machine





Arterio-Venous Shunts

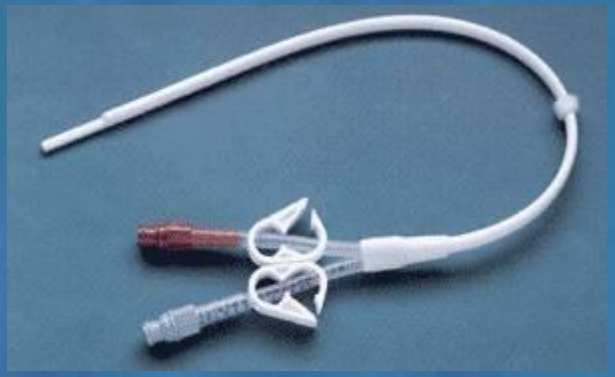
- Large-bore plastic cannula (graft)
- Surgically tied to adjacent superficial artery & vein
- Complications -
  - infection
  - thrombosis
  - disconnection → exanguination



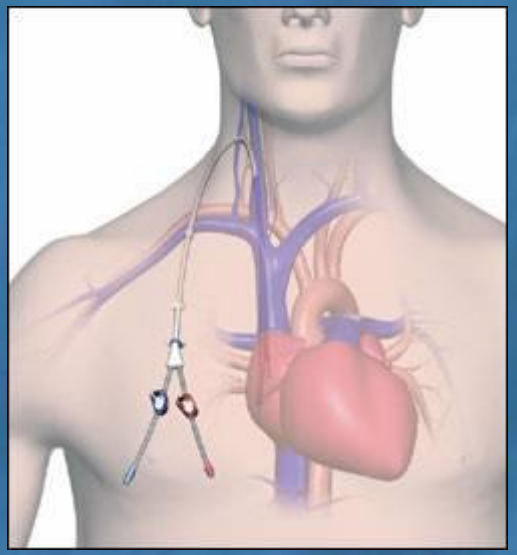
Temporary Dialysis Catheters

- When dialysis is needed immediately
- Large-bore double lumen cannula
- Inserted in to central vein – subclavian, jugular, femoral
- Preferably under ultra-sound guidance
- Can be kept in for short periods only

Semi-Permanent Dialysis Catheters



- When inserted with a skin tunnel – can be kept for longer since risk of infection is less



- BUT – high risk of local & systemic sepsis since catheter is external

- Jugular route preferred

Dialysis Prescription

- Tailoring dialysis to individual patients to obtain optimum results

- Parameters are –

  Dry weight

  Choice of dialysate buffer

  Frequency & duration of dialysis

Dry Weight

- Weight at which patient is neither fluid-overloaded nor fluid-depleted
- Patient is weighed at start of dialysis
- If fluid-overloaded → remove fluid during dialysis to achieve dry weight

Dialysis Buffer

- Usually acetate or bicarbonate
- Sodium & calcium in dialysate carefully monitored

Frequency & Duration of Dialysis

- Average sized adult – 4-5 hours dialysis three times per week
- If using highly permeable synthetic membranes *(high-flux HD)* shorter duration of dialysis is possible
- All patients anti-coagulated with Heparin during dialysis

  (blood coming in to contact with foreign surfaces will activate clotting cascade)

Complications of HD

- *Commonly* – **hypotension**

- *Rarely* –

  anaphylactic reactions

  hard-water syndrome

  haemolytic reactions

  air embolism

Adequacy of Dialysis

- True measures of adequacy are patient morbidity & mortality
- Under-dialysis causes non-specific symptoms

  ie - insomnia, itching, fatigue, restless legs, peripheral sensory neuropathy
- Adequacy assessed by computerized calculation of urea kinetics

HD in Acute Kidney Injury

- Best way of achieving *rapid* biochemical improvement

- Disadvantages -

  haemodynamic instability

  dialysis disequilibrium

Dialysis Disequilibrium

- Due to over-rapid correction of uraemia
- Rapid changes in plasma osmolality causes cerebral oedema
- Disequilibrium manifests as –

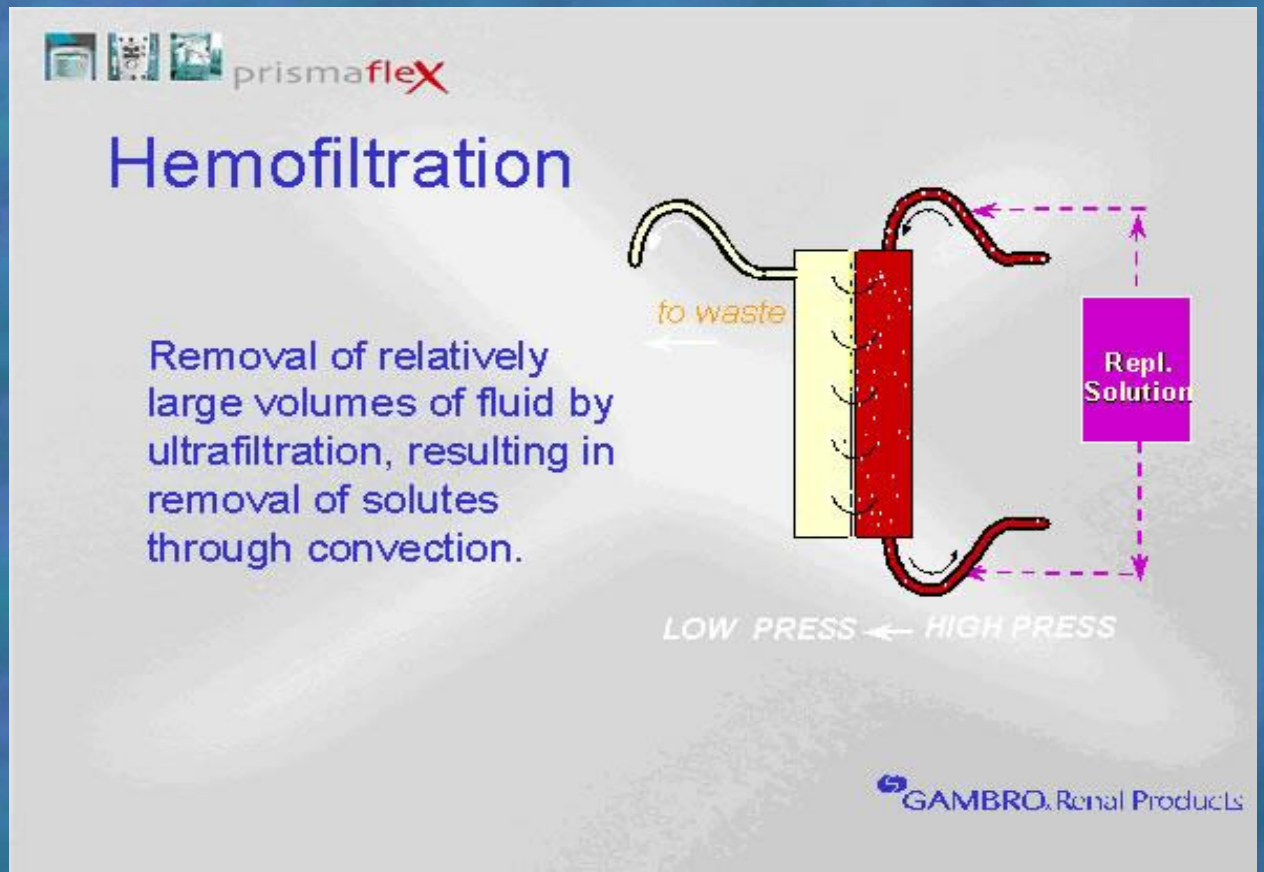
  nausea & vomiting
  restlessness
  headache
  hypertension
  myoclonic jerks
  seizures & coma

Haemofiltration

- Used for both AKI & CKD
- More gentle & for longer periods than HD
- Causes less haemodynamic instability – better for acutely ill patients

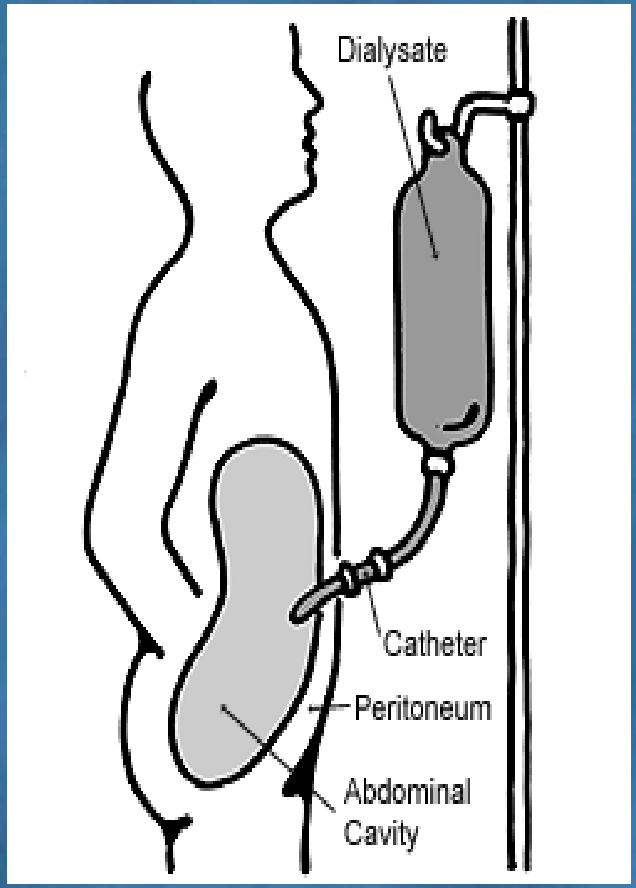
- Remove plasma water & its dissolved constituents (Na, K, urea) by convective flow across high-flux semi-permeable membrane

- Replace with solution of desired biochemical composition



Peritoneal Dialysis (PD)

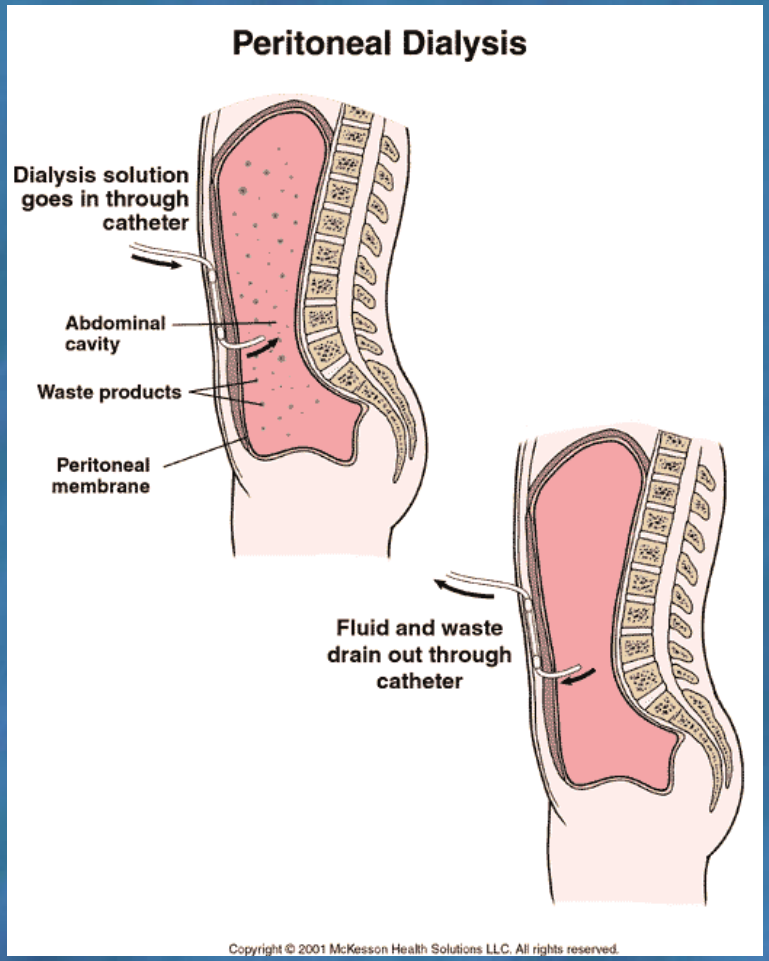
- Uses peritoneal membrane as a semi-permeable membrane
- Tube placed in peritoneal cavity through anterior abdominal wall
- Dialysate run in to peritoneal cavity under gravity



Principles of PD

- Uraemic toxins pass in to dialysate down concentration gradient
- Water attracted in to peritoneal cavity by osmosis

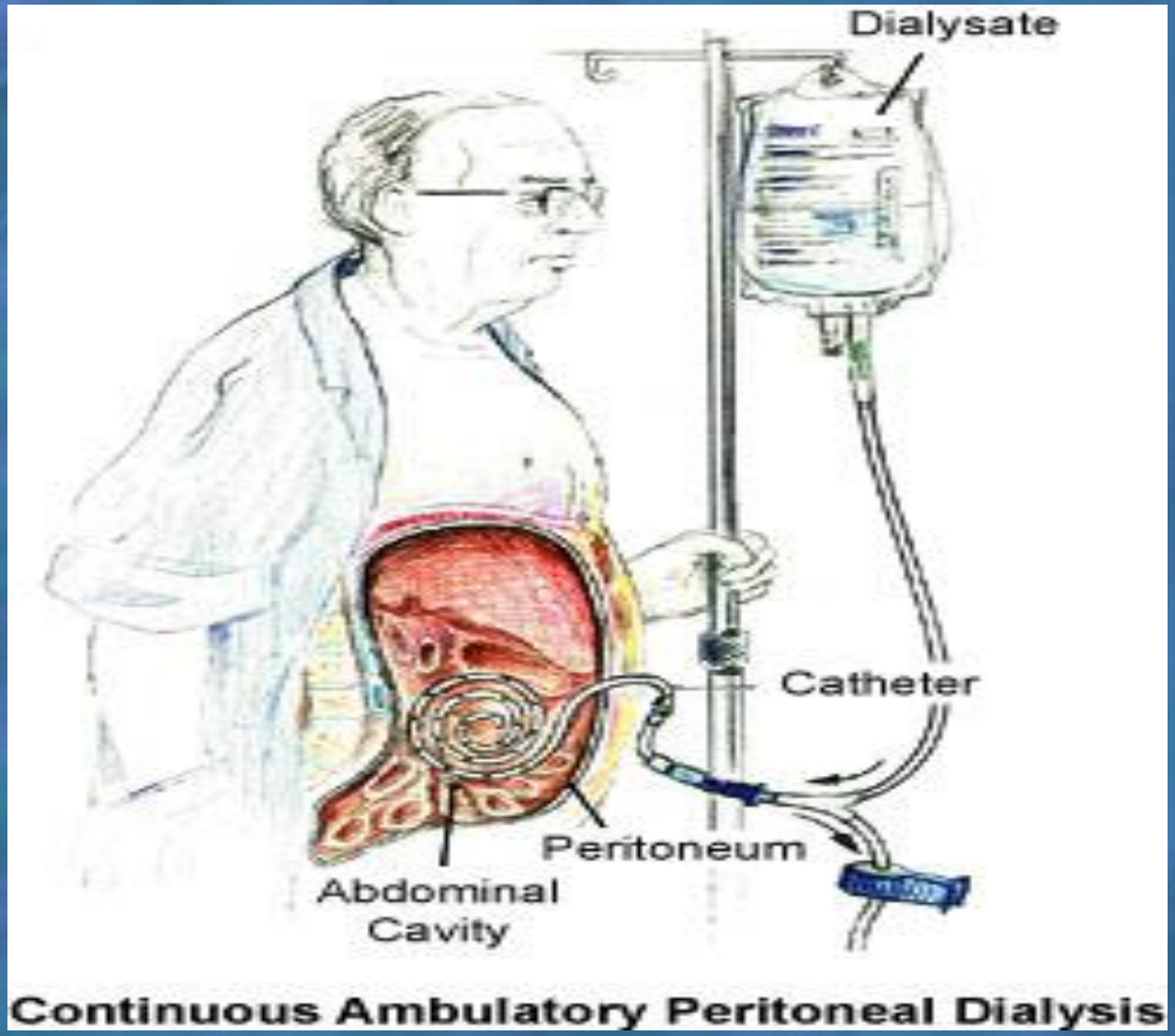
  (Dialysate osmolarity determined by its dextrose content)
- Fluid changed regularly to repeat process



Types of PD

- Continuous ambulatory peritoneal dialysis (CAPD)
- Nightly intermittent peritoneal dialysis (NIPD)
- Tidal dialysis
- Becoming available in SL

CAPD



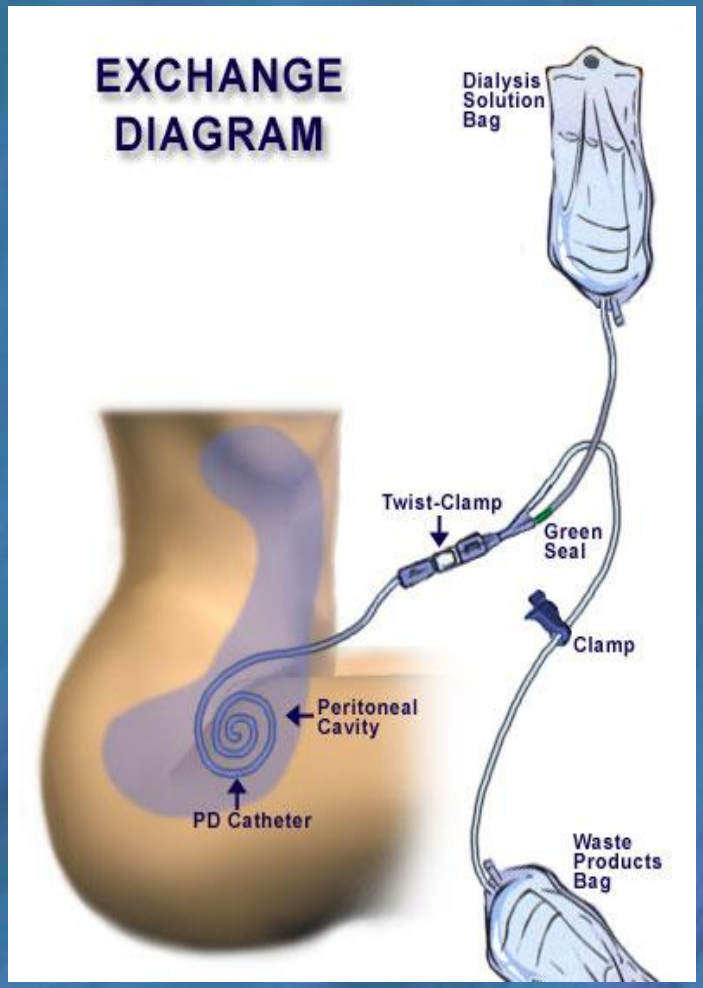
Continuous Ambulatory Peritoneal Dialysis

CAPD

- Dialysate present within peritoneal cavity continuously
- Dialysate exchanges done

  3-5 times/day
- Using sterile no-touch technique to connect bags of dialysate to peritoneal catheter
- Each exchange takes

  20-40 mins
- Used for maintenance PD

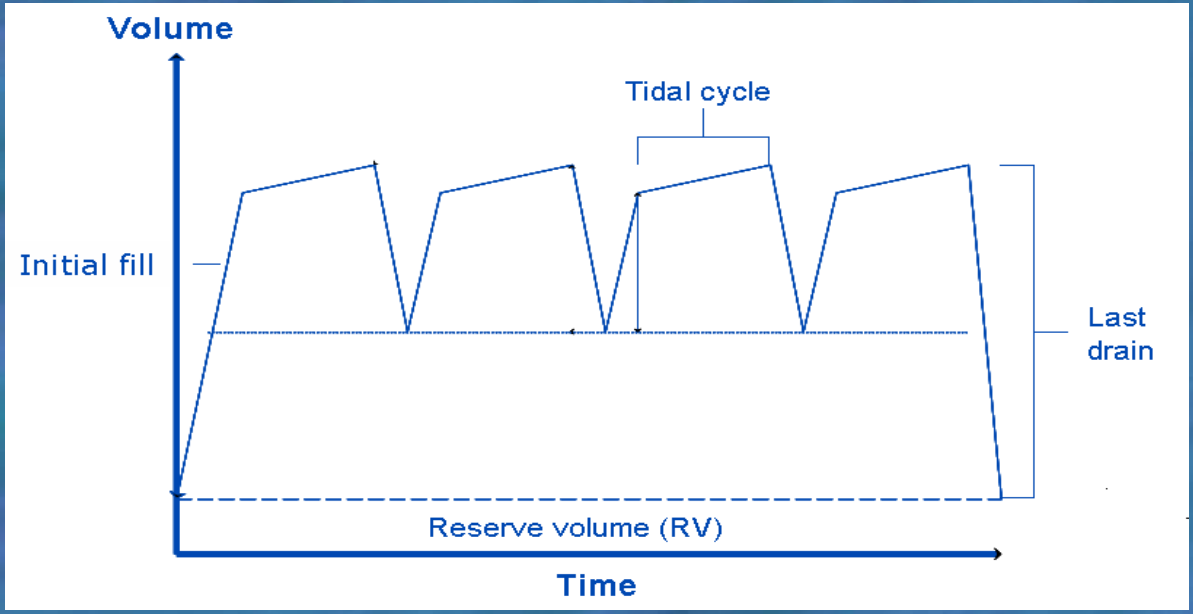


NIPD

- Automated device performs exchanges each night while patient is asleep

Tidal Dialysis

- Residual volume left within peritoneal cavity
- Continuous cycling of small volumes in & out



Complications of PD

- Peritonitis
- Infection around catheter site
- Constipation - common
- Leakage of dialysate

  thru diaphragmatic defect in to pleural cavity → pleural 'effusion'

  down patent processus vaginalis in to scrotum
- Failure of peritoneal membrane function

  with long-term CAPD
- Sclerosing peritonitis – potentially fatal

PD Peritonitis

- Most common serious complication of PD
- Clinical features –
  - abdo pain
  - cloudy peritoneal effluent
  - nausea & vomiting
  - fever
  - paralytic ileus

  (guarding & rebound tenderness unusual)
- Microscopy of PD fluid - >100 neutrophils/ml
- Must culture PD fluid

PD Peritonitis *ct*

- Broad-spectrum antibiotics to cover Gram negative & positive organisms
- Antibiotics given - intra-peritoneally *(preferred)*
  intra-venous
  oral
- Commonly due to *Staph epidermidis* (50%)

Contra-indications to PD

- Unwillingness or inability of patient to learn PD technique
- Previous peritonitis
- Presence of a stoma *(iliostomy, colostomy)*
- Active intra-abdominal sepsis
- Abdominal hernia

  will expand with PD

  must be repaired before starting PD
- Visual impairment
- Severe arthritis

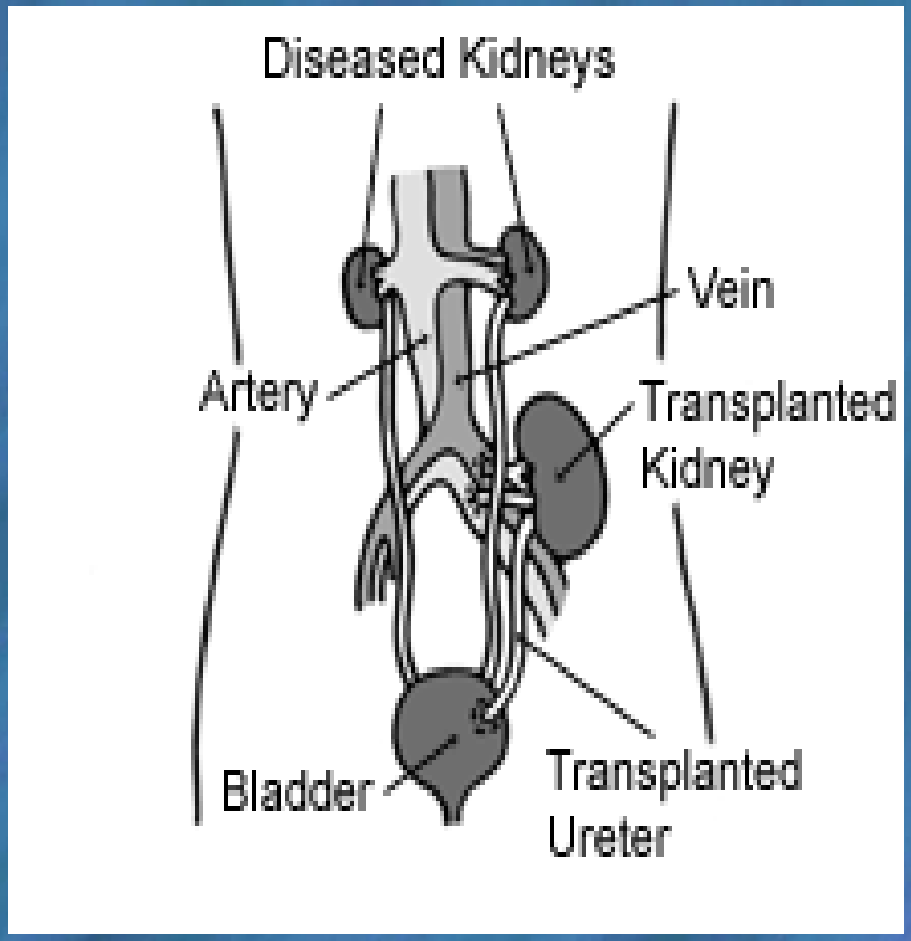
Complications of Long Term Dialysis

- Cardiovascular disease
- Sepsis
- Dialysis amyloidosis

  causes carpal tunnel syndrome or dialysis arthropathy

Renal Transplantation

- If successful → almost complete rehabilitation in ESKD
- Freedom from diet & fluid restriction
- Correction of anaemia & infertility
- Need for parathyroidectomy reduced



- Using kidney from cadaveric donor or living close relative

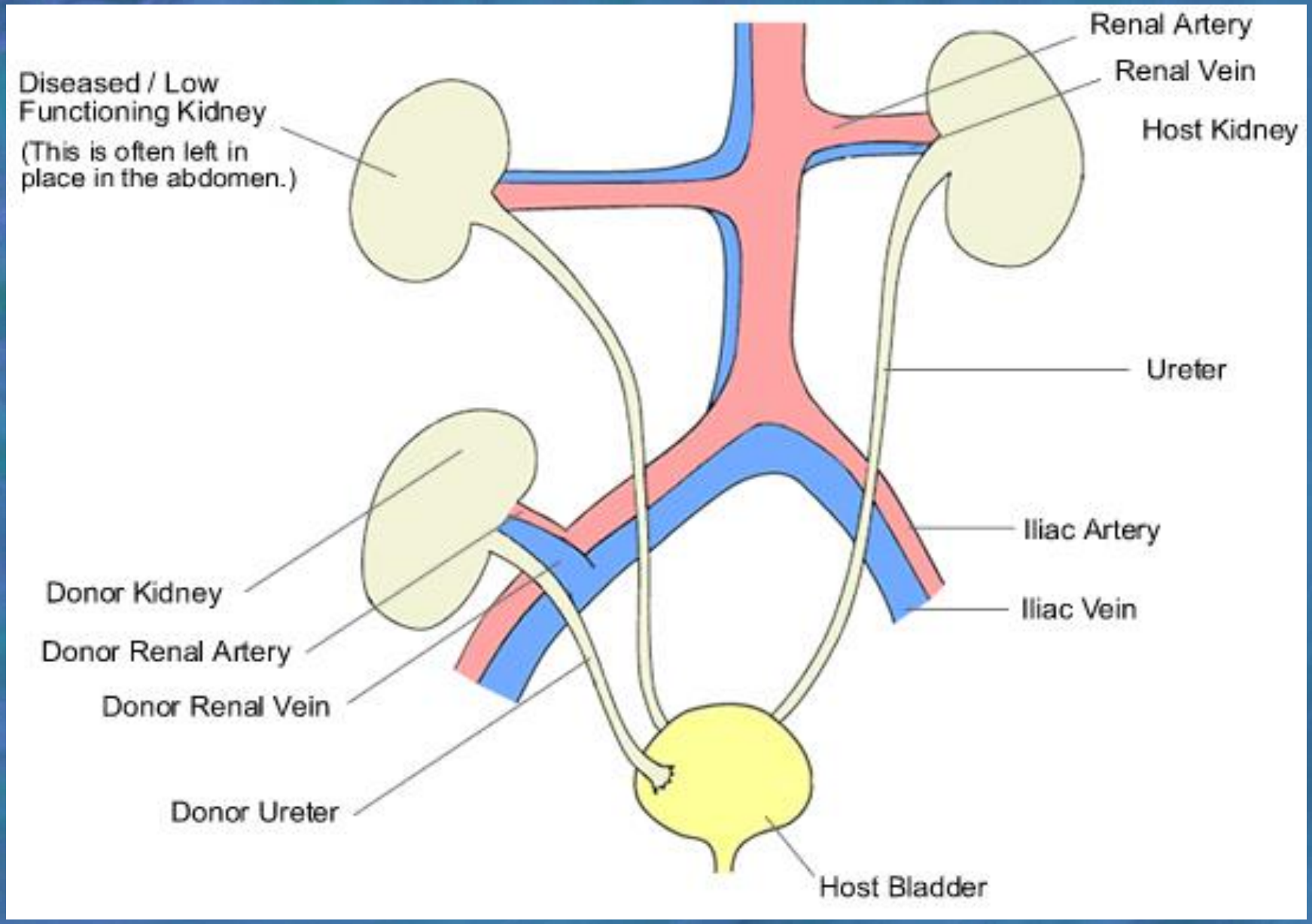
- Anastomose donor kidney to iliac vessels of recipient
  Donor ureter placed in recipient bladder

- Need immuno-suppression *as long as transplant is in place* to prevent rejection

- Donor kidney graft survival –

  80% → 5-10 years

  60% → 10-30 years


Renal Artery
Renal Vein
Diseased / Low Functioning Kidney
(This is often left in place in the abdomen.)
Host Kidney
Ureter
Iliac Artery
Iliac Vein
Donor Kidney
Donor Renal Artery
Donor Renal Vein
Donor Ureter
Host Bladder

Factors Affecting Success of Renal Transplantation

- ABO blood group compatibility between donor & recipient
- HLA type matching donor & recipient
- Adequate immuno-suppression
- Experienced Transplant Centre

Cadaveric Donation

- From patients suffering brain-stem death with still beating hearts
- Consent needed from close relatives if patient is not a registered organ donor

Living Related Donation

- Identical twins are ideal - no need of immuno-suppression
- Close relatives – siblings or parents
- Donor must be aged >18 yrs
- *Donor Pre-op* –

  clinical examination

  measure renal function

  Hepatitis B & C, HIV & CMV status

  renal imaging

Immuno-suppression

- Given long-term to prevent rejection of graft
- Risk of rejection highest in first 3 months post-transplant – most rejection episodes are reversible
- *Drugs used* –
  - corticosteroids
  - azathioprine
  - ciclosporin
  - tacrolimus
  - mycophenolate mofetil
  - antilymphocytic & antithymocytic globulin

Complications of Renal Transplantation

- Technical failures
- Complications of immuno-suppression
- Other complications

Technical failures

- Occlusion or stenosis of arterial anastomosis
- Occlusion of venous anastomosis
- Urinary leaks due to –

  damage to lower ureter

  defects in anastomosis between ureter & recipient bladder

Complications of Immuno-suppression

- **Corticosteroids –** diabetes, hypertension, Cushinoid appearance, osteoporosis & fracture

- **Ciclosporin** – diabetes, hypertension, nephrotoxicity
- **Tacrolimus** – diabetes, nephrotoxicity, neurotoxicity
- **Azathioprin** – hepatotoxicity, bone marrow suppression

General Complications of Immuno-suppression

- Increased risk of skin tumours
- Increased risk of infections, sp opportunistic
- Increased risk of lymphoma

Other complications

- Recurrence of disease that caused renal failure

  eg – MCGN, FSGS, Goodpasture's syndrome

- Lipid abnormalities → ↑ risk of IHD

- De novo glomerulonephritis in grafted kidney

Choice of Renal Replacement Therapy (RRT)

- Ideal – renal transplant
- Age is not a barrier to transplantation
- Choice between CAPD & HD until transplantation
- HD expensive
- CAPD not freely available
- Shortage of donor kidneys
- Post-transplant costs high

Contra-indications to Renal Transplantation

- Sensitization to HLA antigens

  by pregnancy, blood transfusion or previous failed transplant

  is a relative contra-indication only

- Previous malignancy

- Severe non-renal disease

  limiting survival & post-transplant rehabilitation

- Vascular disease, sp in DM