The Renal Continuum of Care

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Statistics

Chronic Kidney Disease (CKD) - Encompasses Stages 1-5

- Affects 15% of Americans
- Often accompanied by comorbidities of Diabetes Mellitus, hypertension, and cardiovascular disease
- 23% of all Medicare spending for those aged 65+ → $16K per capita
- $114 Billion

End Stage Renal Disease (ESRD) - when dialysis or transplantation is required, usually stage 5 CKD

- Less than 1% of the Medicare population
- 7% of all Medicare spending → $90K per capita
- $35 Billion

Table 1. Stages of CKD[a]

Stage	Description	GFR (mL/min/1.73 m²)
1	Kidney damage with normal or GFR	≥ 90
2	Kidney damage with mild GFR	89-60
3A	Mild to moderate GFR	59-45
3B	Moderate GFR	45-30
4	Severe GFR	30-15
5	Kidney failure	< 15 or dialysis

CKD, chronic kidney disease; GFR, glomerular filtration rate.

[a]Adapted from the Renal Association. http://www.renal.org/whatwedo/InformationResources/CKDeGUIDE/CKDstages.aspx. Accessed November 16, 2013.

"2018 Annual Data Report." United States Renal Data System. https://www.usrds.org/adr.aspx

Screening/Early Detection

Some Kidney Physiology

Nephrons

- On the order of 1 million in each kidney
- Rarely regenerate
- Complex systems (a difficult organ-growing challenge)

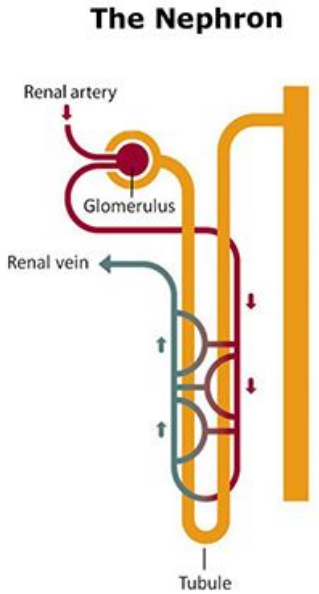
Primary Care Screening

- Urine Analysis
- Blood Panel
  - Creatinine
  - Blood Urea Nitrogen (BUN)
- Diabetes Mellitus or Hypertension

Refer to Nephrologist if screening shows poor values (or don't!)

Nephrologist

- Often don't see patients until Stage 3 CKD or worse



https://www.niddk.nih.gov/health-information/kidney-disease/kidneys-how-they-work

Early CKD Treatment

- Review - what does the kidney do?
  - Filter blood - take out the trash
  - Hormones -
    - Erythropoietin
    - Activated Vitamin D (absorb Ca)
    - ADH
  - Regulate fluid in the body - blood pressure!
  - Regulate electrolytes and pH
    - Na, Cl, K, Ca, Mg, Ph, Bicarb
- Number 1 Rule: Do no harm
- Delay progression of CKD
  - Don’t stress the kidney
- Make up for what the kidney is not doing!
  - Anemia - give Epogen
  - BP/fluid control medication
- Control Diet
  - Medication with food such as phosphate binders

Acute Kidney Injury (AKI)

- Traumatic events can result in loss of kidney function
- Wait and see
- 30% of AKIs progress into CKD within a year as kidneys are unable to regenerate
- Continuous Renal Replacement therapy (CRRT, dialysis all the time) frequent in ICU
- Selena Gomez

https://www.sciencesource.com

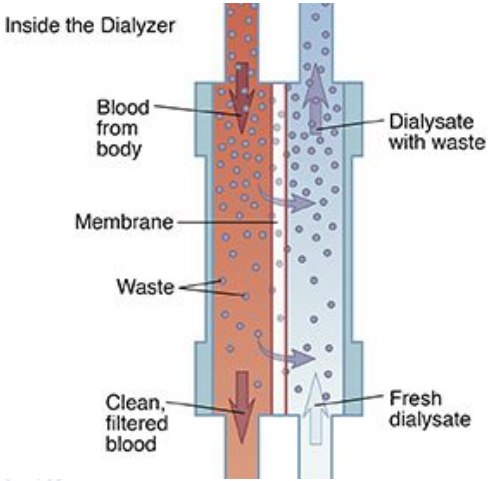
Pre End Stage Renal Disease Problems and Potential Solutions

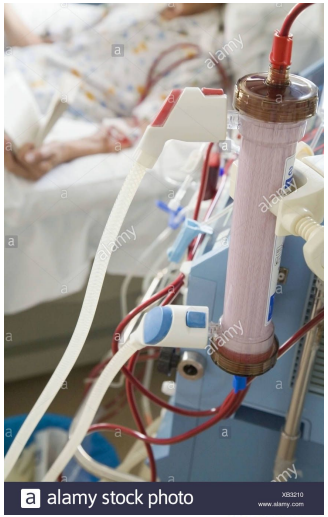
- As we have discussed there is not a good screening method for decreased renal function until it becomes dangerous (your kidneys just work extremely well).
  - GFR measurements
  - Primary Care Physicians do not always catch CKD until late into the disease
- AKI in the ICU
  - Sometimes procedures in the Hospital can permanently damage kidney function
- Medication “altercations” between doctors of different specialties and Nephrologists

The Meat: End Stage Renal Disease and Dialysis

Briefly: What is dialysis?

- Process of removing excess water, solutes, and toxins from the blood in people whose kidneys can no longer perform it naturally.

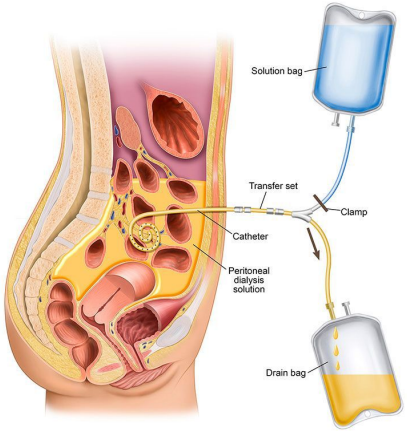




Main Types of Dialysis

At home dialysis:

1. Peritoneal
2. Hemodialysis

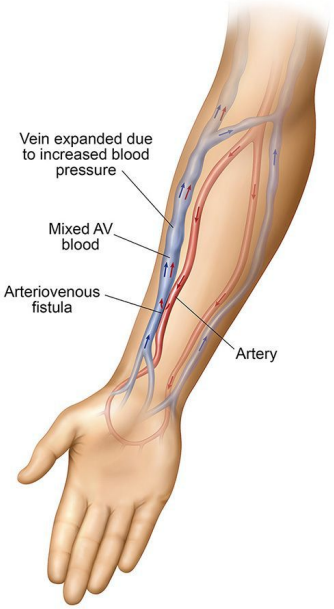


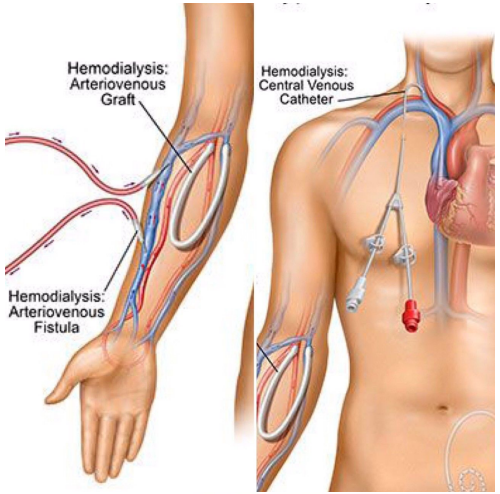
In Clinic Dialysis:

1. Hemodialysis

Preparing for HD

1. Make sure you need dialysis (we saw patients at 23% kidney function and they were kept off dialysis)
2. Get a vascular access
   a. Fistula
   b. Graft
   c. Cuffed Catheter
3. Wait for access to mature





Some Problems (Small Picture)

Dialysis Access:

- Stenosis/ Aneurysms
  - Need for Interventional Radiology
- Aesthetic
- Caring for access
  - Catheter must stay out of water
  - Fistulas and grafts must be well protected from outside forces
- Infection, Infection, Infection. Infection

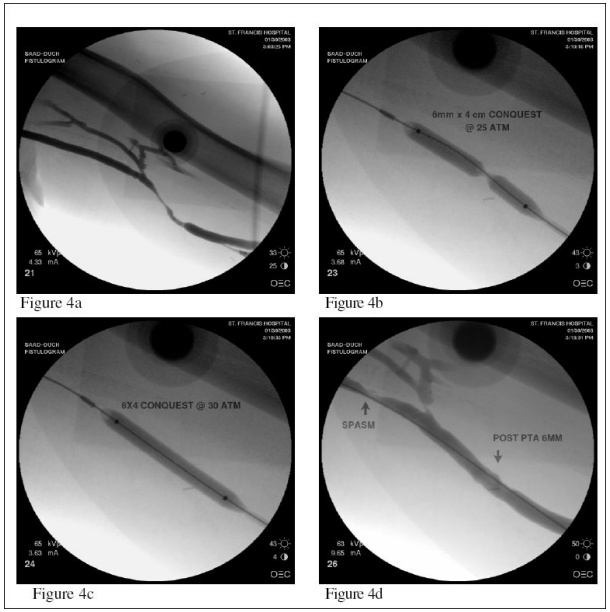


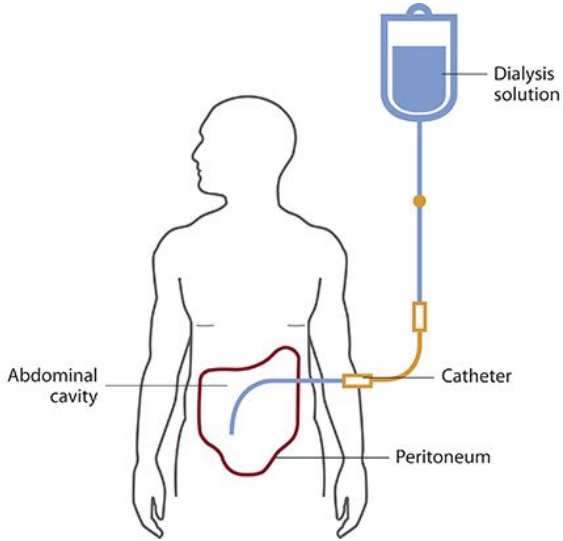
Figure 4a Figure 4b Figure 4c Figure 4d

HD Mechanics

1. Nurse prepares machine
    a. Tubes, prime with saline, ensure operation of machine
2. Patient is seated
    a. M/W/F or T/T/S
    b. Triage
3. Arterial and Venous cannulation
4. Treatment, 3+ hours
    a. Alarms handled by nurses
5. Patient taken off machine
6. Nurse cleans machine

Peritoneal Dialysis (PD)

- Peritoneum acts as the filter
- Set number of “dwells” per day
- Can be automated overnight using a cycler
- Use of glucose solution as “dialysate”
- Prone to infection - lots of catheter tip changing done by the patient
- Performed completely at home



Big Picture Problems

Dialysis Technologies:

- ***Insufficient kidney replacement***
  - Larger molecules left in body
  - More intense treatment unlike kidneys
  - No hormone replacement
  - pH control
  - Limited in fluid balance (non-dynamic prescription)

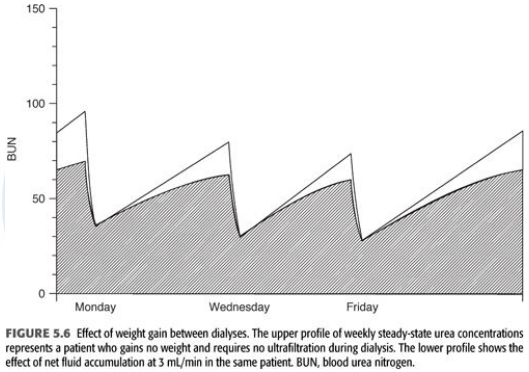


FIGURE 5.6 Effect of weight gain between dialyses. The upper profile of weekly steady-state urea concentrations represents a patient who gains no weight and requires no ultrafiltration during dialysis. The lower profile shows the effect of net fluid accumulation at 3 mL/min in the same patient. BUN, blood urea nitrogen.

Patient Compliance:

- Transportation. logistics
- Eating/Drinking before/during dialysis
- Insufficient clearance (prescription not fulfilled)

How do we get the patient to care for themselves?

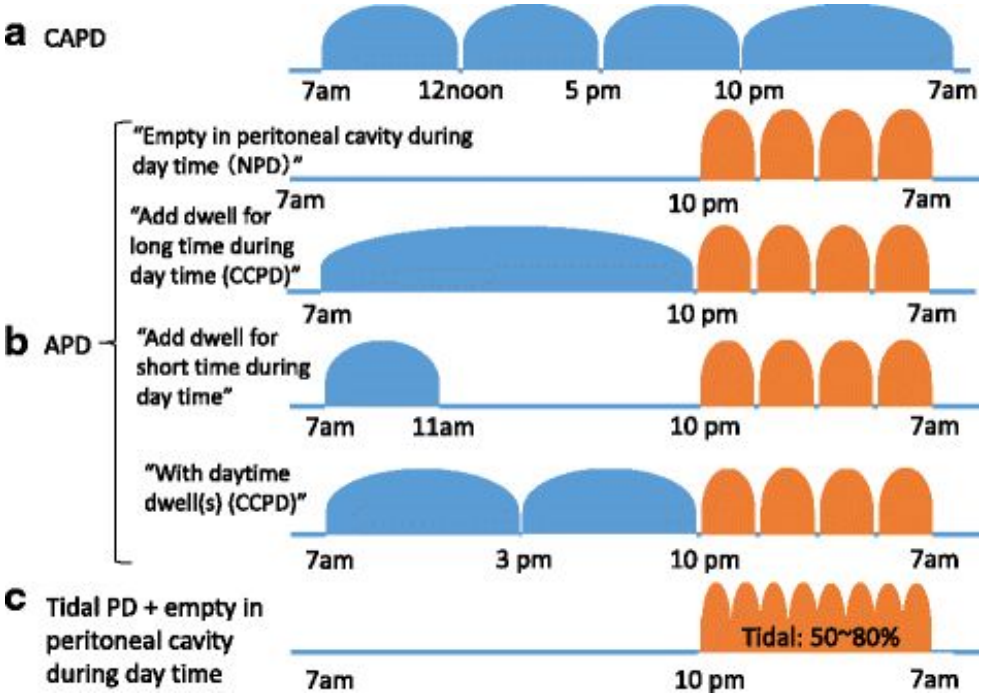
- Diet
- Vascular access care
- Ensure quality of life
- DM and HTN management
- Near-constant appointments

Quality of Life

- Patient Compliance

How would you feel about going on dialysis?

- Which form of dialysis would you choose?
- Living day-to-day, week-to-week
- Travel
- Aesthetics of vascular access
- Long term - 5+ years



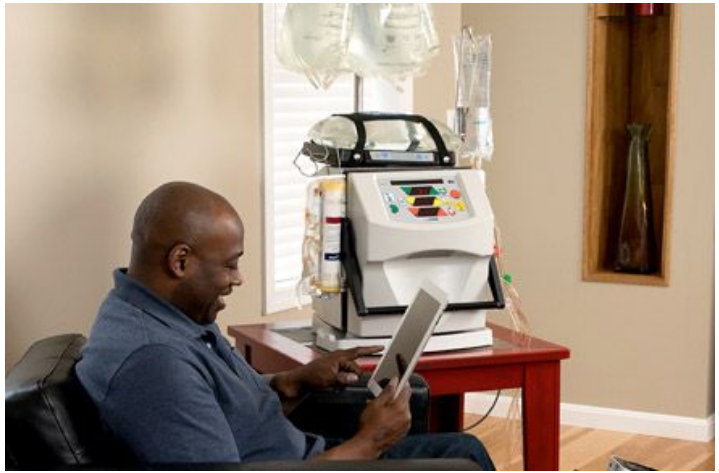
Move Towards Home Dialysis?

Pros:

- Cheaper for government
- Get rid of travel logistics
- Same or better health outcomes
- One person on one machine

Cons:

- Many people don’t trust themselves
  - Overwhelming with many steps
  - Need to be careful
- Cannulation or needlesticks
- Often times need a caretaker
- Must have dexterity/vision
- More frequent dialysis
- Access to internet



Questions?

Possible Solutions

Screening/Advertisement

- CKD is a public health issue
- CKD can happen to anyone, often to people that don’t see their PCP
- Only 57% of those with Stage 4 CKD know it!
- Screening in public urinals
  - Insert rapid chemical assay to measure protein in urine - turn urine a different color
  - Urinal “cake” system
- No good way to measure GFR - collate data to measure GFR based on other data - machine learning

www.homedepot.com

Possible Solutions

Peritoneal Dialysis

- Infection is a problem
- Fresenius stay-safe device (shown right)
- Must unscrew and move an open catheter tip from the “Extension” slot to the middle to fill the peritoneal cavity, then to “New Cap” Position
  - Too much chance for infection
  - Two chances for people to infect themselves

https://fmcna.com/products/home-dialysis-equipment/peritoneal-dialysis-devices/stay-safe-overview/

Home Hemodialysis

- Tubing and dialyzer
  - Need to flush with saline: must be rough to get air bubbles out
- Errors read at E + #:
  - Doesn't directly tell you how to problem solve

HD Hoteling

- Staffing is a large contributor to difficulty of in-clinic dialysis
- Instead, use “Hotelling” model where patients reserve seats, self-cannulate and run the machine
- Staffing can be more sparse and cover a larger time-frame
- Option of nocturnal dialysis

Even More Ideas

- Personalized dialysis prescription based on body's current solute concentration - rapid analysis instead of waiting monthly for labs
- ICU real time data analysis for preservation of kidney
- Better vascular access flow estimation before fistulagram or IR procedure
  - When is a stenosis flow limiting?
- Better kidney health biomarker or predictor (similar to data-based screening)
- Effluent dialysate data monitoring - more accurate test of solutes taken up by and removed from dialysis patient - measure completeness of treatment

Slide ideas

- Current statistics
- Current kidney health/considerations/risk factors
  - CKD, AKI
- Stages of kidney disease
- Dialysis Technologies (What we've seen)
  - Getting ready/vascular access/IR
  - Conventional, in-clinic
  - Home
    - Hemo
    - PD
- Transplant
- Future of kidney health
- Push for innovation/government support
- Current challenges for kidney patients
  - QoL
  - Infection
  - Compliance
  - Comorbidities (CVD, mineral bone diseases, HTN, burnout/conservative therapy, old age)
- Ideas for improvement