EMS Care for the Renal Patient

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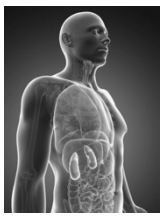
Presentation Outline

Prevalence and Incidence of Kidney Disease in the United States
Review of Anatomy and Physiology of the Kidney
Pathophysiology of Kidney Disease
Treatment Modalities
- Hemodialysis
- Peritoneal Dialysis
- Transplantation

Assessment of the Kidney Patient
EMS care concerns with the Renal Patient
- Vascular Access Issues
- Fluid Overload and Pulmonary Edema
- Hypotension in Hemodialysis Patients
- Cardiac Arrest in the Renal Patient
- Depression

Case Reviews
Future of Kidney Care Q&A

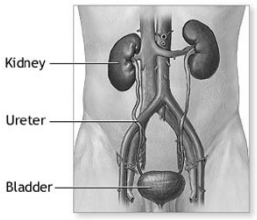


CKD and ESRD in the US

- **Chronic Kidney Disease (CKD)**
  - Prevalence (2010): More than 10 percent of people ages 20 years and older (>20 million)
- **End Stage Renal Disease (ESRD)**
  - Prevalence (2008): 547,982 under treatment
  - Incidence (2008): 112,476 were new beneficiaries of treatment
- **Cost of Care**
  - Cost for the ESRD program (2008): $39.46 billion in public and private spending
  - Annual mortality rates for dialysis patients (number of deaths per 1,000 patient years at risk, unadjusted) has decreased 7.7% since 1990

Basic Function of the Kidney

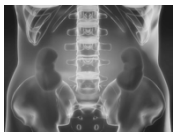
- Every day, a person's kidneys process about 200 quarts of blood to sift out about 2 quarts of waste products and extra water.
- Wastes in the blood come from the normal breakdown of active tissues, such as muscles, and from food.
- The wastes and extra water become urine, which flows to the bladder through tubes called ureters.
- The bladder stores urine until releasing it through urination.



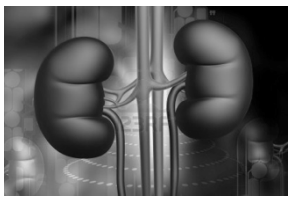
A.D.A.M.

Anatomy of the Kidney

- Two bean shaped solid organs
- Located on each side of the spinal cord
- Retroperitoneal at the 12th thoracic and third lumbar vertebra.
- Right kidney is slightly lower to the left

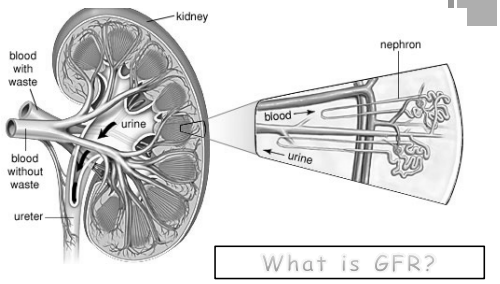


Anatomy of the Kidney



- Blood enters the kidney from the Aorta to the Renal Artery
- Blood leaves the Kidney from the Renal Vein to the Inferior Vena Cava
- 25% of the total cardiac output, or 1300 ml of blood pass through the kidneys per minute

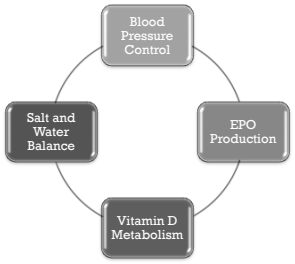
Physiology of the Kidney



What is GFR?

Physiology of the Kidney

- **The kidney has four basic functions:**



Blood pressure control

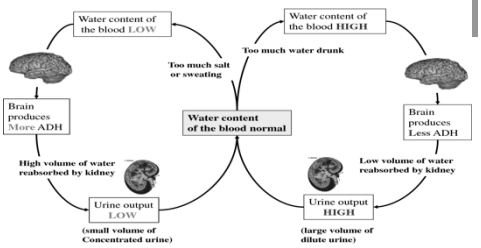
Blood and Extracellular Volume

- The kidneys processes and eliminate electrolytes such as Sodium and Potassium with excess fluids.
- A higher volume of fluid leads to higher blood pressure.
- Kidneys regulate blood pressure through maintaining electrolyte balance.

Renin

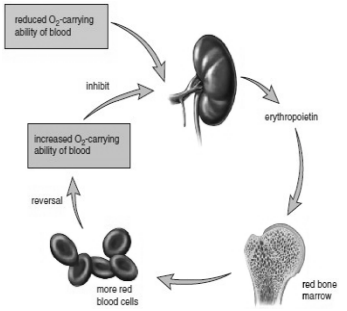
- The kidney carefully monitors the amount of blood flowing through the renal arteries and if blood flow drops, it secretes a hormone called renin.
- This allows the body to increase blood pressure if it gets dangerously low.
- It can also lead to abnormally elevated blood pressure if kidney blood flow is reduced.

Salt and water balance

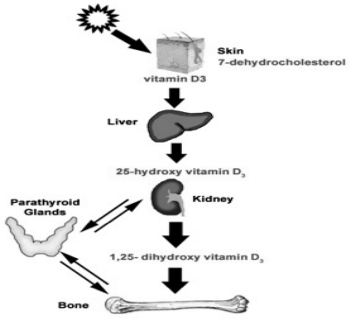


- **The amount of water in the blood must be kept more or less the same all the time to avoid cell damage.**
- **This is maintained through the antidiuretic hormone (ADH) secreted by the hypothalamus**

Erythropoietin production

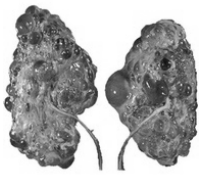


Vitamin D metabolism

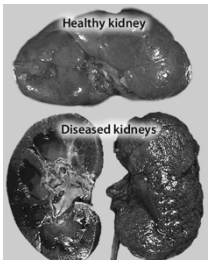


+ Pathophysiology of Kidney Disease

- Regardless of the primary cause of nephron loss, some usually survive or are less severely damaged
- These nephrons then adapt and enlarge, and clearance per nephron markedly increases.
- If the initiating process is diffuse, sudden, and severe, such as in some patients with rapidly progressive glomerulonephritis, acute or sub acute renal failure may ensue with the rapid development of ESRD.
- In most patients, however, disease progression is more gradual and nephron adaptation is possible.



+ Pathophysiology of Kidney Disease



- Focal glomerulosclerosis develops in these glomeruli, and they eventually become non-functional.
- At the same time that focal glomerulosclerosis develops, proteinuria markedly increases and systemic hypertension worsens.
- This process of nephron adaptation has been termed the "**final common path.**"

+ Uremia

- Uremia is a clinical syndrome associated with fluid, electrolyte, and hormone imbalances and metabolic abnormalities.
- The term uremia, literally means urine in the blood.
- No single uremic toxin has been identified that accounts for all of the clinical manifestations of uremia.
- ***Metabolic Acidosis***

Etiology of Acute Kidney Injury

- **ABOUT A 50% Mortality Rate**
- **Pre-renal failure:**
  - Hypovolemia
  - Volume overload with reduced renal perfusion
  - Peripheral vasodilation, as in septic shock
- **Intrinsic renal failure:**
  - Sepsis syndrome, systemic hypotension or nephrotoxic agents
  - Acute allergic nephritis due to antibiotics and other drugs
  - Kidney injury following vascular procedures or contrast studies
- **Post-renal failure:**
  - Ureteric obstruction
  - Bladder outflow obstruction

Phases of ARF

- Oliguric phase: GFR decrease, hyperkalemia, fluid overload, elevated BUN & creatinine.
- Diuretic phase: GFR Begins to increase, hypokalemia, hypovolemia, gradual decline in BUN, creatinine.
- Recovery phase: BUN is stable & normal, complete recovery may take 1 to 2 years.

Etiology and Risk Factors of Chronic Kidney Disease

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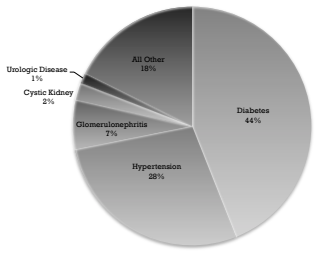
Comorbidities Driving ESRD, USA 2008



Relative Risk of ESRD
African American - 4.45x
Hispanic - 3.60x
Native American and Asian

Risk Factors
Diabetes mellitus
Hypertension
Family history
Obesity/metabolic syndrome
Reduced kidney mass
Low birth weight
Older age
Low income/education

Chronic Kidney Disease

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Detection
Early detection and treatment can help prevent the progression of kidney disease to kidney failure

Three simple tests can detect CKD
Blood Pressure, Urine Albumin, Serum Creatinine (Calculate GFR)

Signs of CKD

Lethargy
Difficulty concentrating
Decreased appetite
Difficulty sleeping
Muscle cramping
Edema
Puffiness around your eyes
Dry, itchy skin
Increased frequency of urination
Often asymptomatic

Phases of CKD

Table 1. Stages of Chronic Kidney Disease

Stage No.	Stage Description	GFR, mL/min/1.73 m²
1	Kidney damage with normal or increased GFR	≥90
2	Kidney damage with decreased GFR	60-89
3	Kidney damage with moderately decreased GFR	30-59
4	Kidney damage with severely decreased GFR	15-29
5	Kidney failure	<15 or dialysis

Abbreviation: GFR, glomerular filtration rate.

End Stage Renal Disease

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In end-stage renal disease, the kidneys are functioning at less than 15% of their normal capacity.

When this occurs, dialysis or a kidney transplant is necessary.

Dialysis is a mechanical way to provide filtration of the blood and fluid that the diseased kidney can no longer support.

There are two types of Dialysis
-Hemodialysis
-Peritoneal Dialysis

+ Dialysis Treatments by Modality

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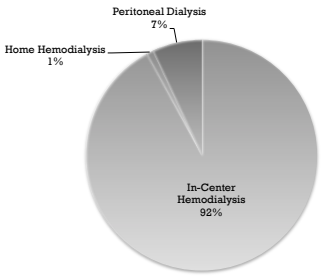

+ Treatment of ESRD

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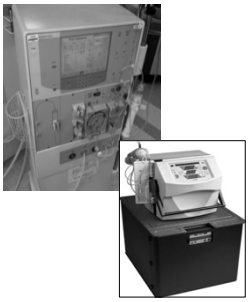
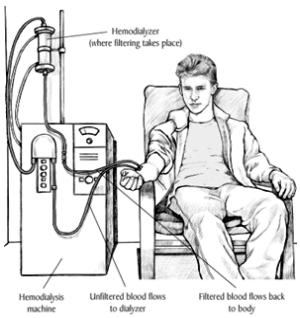
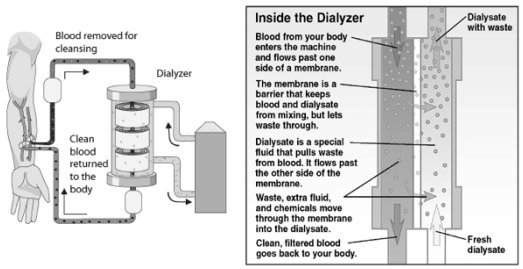


- **Hemodialysis**
  - The use of a machine as an artificial kidney to filter a patients blood.
  - Hemodialysis may be performed at a dialysis unit or at home when certain criteria and training have been met.

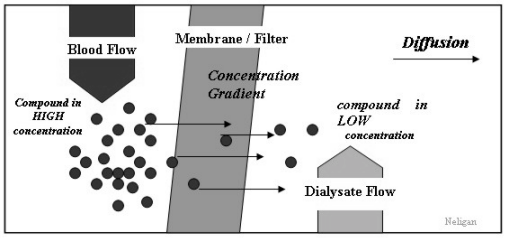
+ Hemodialysis



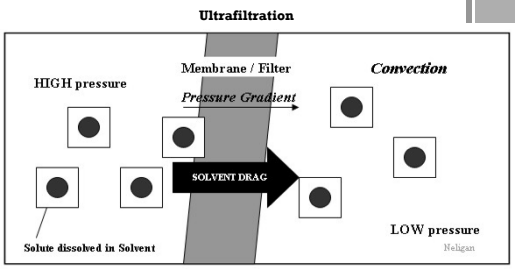
How Does Hemodialysis Work?



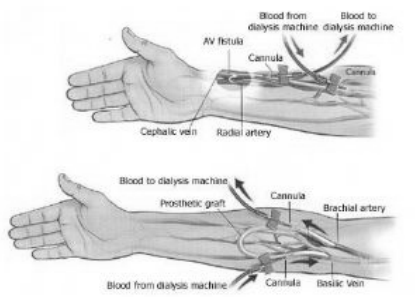
How Dialysis Works?



How Dialysis Works?



Hemodialysis Vascular Access



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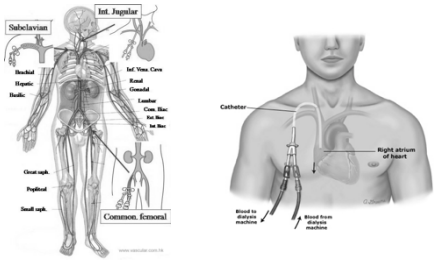
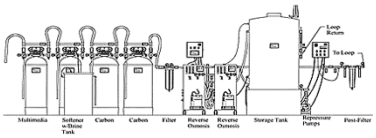


Hemodialysis Water System



Treatment of ESRD

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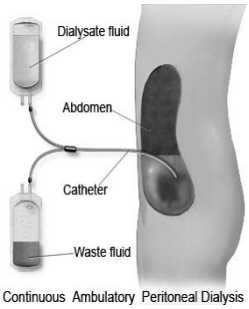

Continuous Ambulatory Peritoneal Dialysis

- **Peritoneal dialysis**
  - Generally done daily at home
  - An exchange of fluid through a catheter in the abdomen using the peritoneal membrane as a filter for waste

Treatment of ESRD

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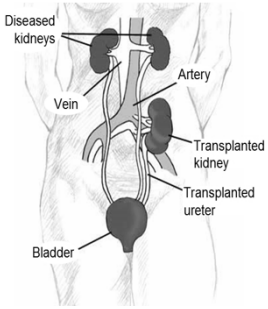


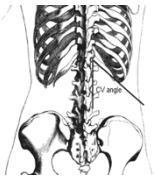
- **<u>Kidney transplantation</u>**
  - Patient can receive a kidney from a living or a deceased donor
  - >90,000 patients on waiting list

Assessment of the Renal Patient

- **Inspection**
  - Skin- pallor, yellow-gray, excoriations, changes in turgor, bruises, texture(e.g. rough, dry skin)
  - Mouth: stomatitis, ammonia breath.
  - Face & extremities- generalized edema, peripheral edema, bladder distention, masses, enlarged kidney.
  - Abdomen-abdominal contour for midline mass in lower abdomen (may indicate urinary retention) or unilateral mass.
  - Weight: weight gain 2nd to edema, weight loss & muscle wasting in renal failure.

Assessment of the Renal Patient

- **General state of health**
  - Fatigue, lethargy, & diminished alertness.
- **Palpation**
  - No costovertebral angle tenderness, non-palpable kidney & bladder, no palpable masses.
- **Percussion**:
  - Tenderness in the flank may be detected by fist percussion. If CVA tenderness & pain are present, indicate a kidney infection or polycystic kidney disease.
- **Auscultation:**
  - The abdominal aorta & renal arteries are auscultated for a bruit, which indicates impaired blood flow to the kidneys



Uncontrolled Bleeding from Vascular Access

CVC Infection

With Redness

Photo courtesy of ZJ Twardowski

With Pus

Complications of Hemodialysis

- **Hypotension** - A decrease in blood pressure is the most frequent complication reported during hemodialysis.
  - When fluid is removed during hemodialysis, the osmotic pressure is increased and this prompts refilling from the interstitial space.
  - The interstitial space is then refilled by fluid from the intracellular space. Excessive ultrafiltration with inadequate vascular refilling plays a major role in dialysis induced hypotension.
  - The immediate treatment to hypotension is to discontinue dialysis and place the patient in trendelenburg position. This will increase cardiac filling and may increase the blood pressure promptly.

Complications of Hemodialysis

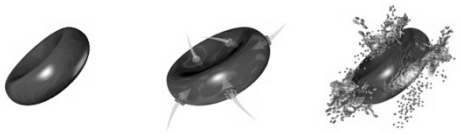
- **Cramps** - In the majority of hemodialysis patients, cramps occur toward the end of the dialysis procedure after a significant volume of fluid has been removed by ultrafiltration.
- The immediate treatment for cramps is directed at restoring intravascular volume through the use of small boluses of isotonic saline.

Complications of Hemodialysis

- **Disequilibrium Syndrome**
- Post Dialysis
- Headache, Nausea, Fatigue, Seizure
- There are two theories to explain it;
  - First theory postulates that urea transport from the brain cells is slowed in chronic renal failure, leading to a large urea concentration gradient, which resulting in reverse osmosis.
  - Second theory postulates that organic compounds are increased in uremia to protect the brain and result in injury by, like in the first theory, reverse osmosis.

Complications of Hemodialysis

- **Hemolysis** - Hemolysis may result from a number of biochemical and toxic insults during the dialysis procedure.
- The half-life of red blood cells in renal failure patients is approximately one half to one third of normal and the cells are particularly susceptible to membrane injury.
- **Human Error – A DIALYSIS MCI?**

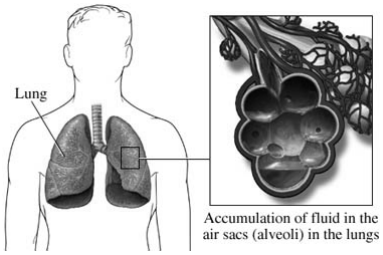


Complications of Hemodialysis

- **Hypoxemia** - A fall in arterial PO_2 is a frequent complication of hemodialysis that occurs in nearly 90% of patients.
- **Febrile reactions** - Febrile episodes should be aggressively evaluated with appropriate wound and blood cultures. The suspicion of infection should be high.

Fluid Overload

Pulmonary Edema

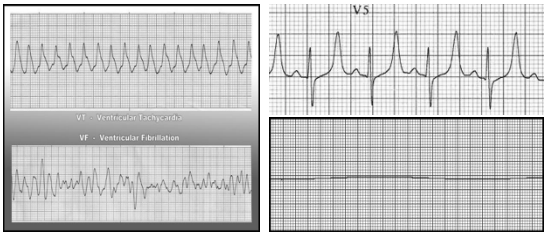


Anemia

- Kidneys can no longer produce EPO.
- No EPO = Decreased RBC Production = Anemia
- Use of ESA
- Higher risk of cardiovascular issues with ESA use greater than 12 mg/Dl
- Decrease in the use of ESA as dialysis centers lose reimbursement for elevated hemoglobin.
- Increase utilization of blood transfusion.

Cardiac Arrest in the Renal Patient

- **Arrhythmia** - Patients on maintenance hemodialysis are at risk of cardiac arrhythmias.
- **Dialysis patients with ESRD have several factors that could predispose them to a high risk of ventricular arrhythmias.**



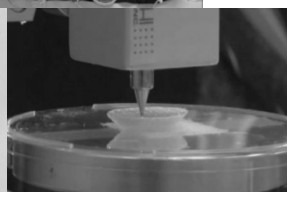
+ Depression

+ Real life - Cases

- So who are some of the people that you have met?

+ Future of Kidney Care Q&A

- **Wearable Kidney**
- **Grown Kidney**
- **3D Printing**



+ Question and Answer

- Q & A