RENAL CERTIFICATION REVIEW

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RENAL
GI/Endocrine/Hematology 18%

Acute Renal Failure
- Chronic Renal Failure
- Electrolyte Imbalances
- Contrast Induced Nephropathy
- ESRD
- Medication induced renal failure
- Nephritic syndrome
Renal

- identify normal and abnormal renal assessment findings
- monitor normal and abnormal renal diagnostic test results
- monitor peritoneal dialysis
- identify medications that may cause nephrotoxicity
- initiate renal protective measures for nephrotoxic procedures
YOU'D BE CRAZY NOT TO BE CERTIFIED!
Anatomy

- Retroperitoneal
- Bilateral to the spine – 12\textsuperscript{th} thoracic and 3\textsuperscript{rd} lumbar
- Left higher than right
- 4”x2”x1” = 0.4% body weight
- Bean shape
Renal cortex
Renal pyramid
Renal artery
Renal pelvis
Renal vein
Ureter
Kidney Layers

- **Capsule**
  - Thin, tough fibrous membrane

- **Cortex**
  - Glomeruli, proximal and distal tubules, waste filtered here

- **Medulla**
  - Concentrates, pyramids, loop of Henle

- **Pelvis**
  - Calyces
Renal Circulation

- Renal artery
- 20-25% of CO = 625cc/min
- Autoregulation
  - Maintain a constant blood flow regardless of BP if MAP is 80-180.
  - Absent if MAP <70
Nephron

- 1.2 million plus each kidney
- Function independently
- Filter blood of unwanted substances and the end products of metabolism
- Glomerulus and tubules and the associated vascular structures
Glomerulus

- Vascular portion of the nephron
- Surrounded by Bowman’s capsule
- Layers
- Semi permeable 10-100X more than normal
- GFR – amount of filtration that occurs
  Normal 125cc/min = 180 l/day
Tubules

- Tubules - one cell layer thick
- Proximal
  - 65% of Na and H2O reabsorbed
  - Freely permeable
  - Filtrate is isotonic
Loop of Henle
- Concentration and dilution of urine
- Counter current mechanism
  - Hypertonic interstitium
- Thin descending loop
- Thick ascending loop
  - Diuretics work here
  - NaCl transport
**Tubules**

- **Distal**
  - ADH acts here -> water reabsorption
  - Aldosterone -> Na reabsorption
  - Fluid hypotonic or isotonic
  - Ph fine tuning
    - H secreted, NH3 secreted
    - HCO3 reabsorbed
Tubululues

Collecting

- Final adjustments made in urine - Na, K
- Water reabsorbed in final concentrating operation
- ADH required
Functions

- Urine formation
  - 1-2 cc/kg/hour

Overview - 3 processes

1. Filtration
   - Molecular size
   - Filtrate = blood plasma - proteins
   - Glomerular filtration rate (GFR)

2. Reabsorption
   - 99% H₂O and salts
   - Active and passive mechanisms

3. Secretion
   - Selective
   - Active transport

Fig. 14-21
Functions

- Electrolyte balance
  - Reabsorption and secretion in tubules
  - Refer to electrolyte handout
Functions

Acid base balance

- Reabsorption or secretion of H or HCO3
- Takes hours to days to respond, but very effective
- Acidosis – increased HCO3 reabsorption
- Alkalosis – less ammonia made
Functions

**BP regulation**
- Renin angiotensin system
- Renin produced in juxtaglomerular cells
- Stored inactive
- Aldosterone also stimulated
- Prostaglandins A, D, E → vasodilation and inhibit ADH
Angiotensinogen → Renin → Angiotensin I → Converting enzyme → Angiotensin II → Stimulation of aldosterone secretion → Aldosterone → Increased water and sodium retention → Increased Preload → Constriction of vascular smooth muscle → Increased Afterload
Functions

Blood component production and hormone regulation

- Renin
- DHCC - 1,25-dihydroxycholecalciferol
  - Active form of Vitamin D
- Erythropoietin – stimulated bone marrow -> increased RBC production
  - Epogen
Functions

- Regulation of over 200 wastes
- BUN
  - Nitrogenous waste product of protein metabolism
  - Unreliable measure of renal function
    - Urine flow, dehydration, hypoperfusion, catabolism, drugs, diet, change in protein metabolism
Functions

Regulation of body wastes

Creatinine

- By product of muscle metabolism
- Amt – constant/muscle mass
- Freely filtered and not reabsorbed or secreted – GFR
- Creatinine clearance = renal function
Renal Function Assessment

Physical
- Skin turgor; mm; edema/ascites; JVD
- Rales/dyspnea; tachycardia; hypotension;
- LOC; seizures; muscle strength

I/O; Daily weights

Labs –
- HCT/HGB; Osmolality; BUN/CR ratio; Sp gravity

EKG changes
Acute Renal Failure

- A rapid deterioration in function that results in the accumulation of nitrogenous wastes, and the inability to regulate electrolyte and fluid balance

- Decreased GFR
  - Oliguria, functions of kidney decline/cease

- 50-60% patients recover function

- 40% mortality
Pre renal Failure

- Most common outside ICU
- Any condition that interferes or decreases blood flow to the kidneys.
- Decreased renal blood flow -> decreased GFR
- Nephrons & tubules remain intact
- Reversible
- May proceed to ATN
Pre Renal Failure Causes

- Decreased circulating volume
- Decreased cardiac output
- Decreased vascular resistance
- Shock
- Renal artery stenosis
Pre renal failure
Clinical Presentation

- Decreased RBF -> decreased pressure in renal artery -> vasoconstriction -> ischemic damage to kidney -> decreased GFR -> proximal tubule to reabsorb Na and H2O = Una <10-15 meg/l
- Fluid deficit = Aldosterone and ADH activated
- Oliguria, concentrated urine with high specific gravity (>1.015) and osmolality (>500)
Pre Renal Manifestations

- Decreased circulating volume
- Decreased PVR
- Tachycardia/hypotension
- Orthostatic BP
- Dry mucous membranes
- Decreased CVP/PAOP
Pre renal failure treatment

- Treat the Cause
- Support circulating volume
Intra renal failure

- Disease of the kidney itself, the nephron, glomeruli, tubules, interstitium, or vasculature in cortex or medulla
- ATN – medullary damage; most common
- GFR and tubular function ceases
- Most common in the ICU
ATN

- Injury secondary to decreased renal blood flow
- Affects medullary area = hypoxia
- Hypoperfusion -> structural damage and basement membrane is disrupted
- Capillaries swell and slough off -> obstruction of glomerulus and tubules -> decreased GFR and urine output = self perpetuating process
ATN Causes

- Hypovolemia
- Sepsis/anaphylaxis
- Cardiogenic - failure
- Pigment induces - Transfusion reactions/myoglobin
- Pancreatitis, gastritis
- Aortic cross clamp

- Obstruction - extra renal/intrarenal
- Vascular diseases
- Glomerulonephritis
- Interstitial nephritis
- Nephrotoxins
Nephrotoxic Meds

- Amikacin
- Ampho B
- Cimetidine
- Contrast media
- Corticosteroids
- Furosemide
- Mycins
- Salicylates
- Sulfonamides
- Tetracyclines
- Vancomycin
- AND MANY MORE
Nephrotoxic Causes

- **Antibiotics**
  - Cephalosporins, PCN, aminoglycosides

- **Metal**
  - Copper gold sulfate

- **Organic solvents** – carbon tetrachloride

- **Heme pigments**

- **Miscellaneous**
  - Contrast dye, fluorinated anesthesia, NSAIDS, Chemo
Cortical Intrarenal Failure

- Affect cortical area
- Not seen in critical care
- Infections
- Vascular damage
- Immunological process
Phases of ATN

- Onset
- Oliguria
  - GFR decrease; Sudden BUN/CR increase; causes imbalances – no time to accommodate to symptoms; 10-14 days
  - Treatment: dialysis (excretion of wastes), renal diet, fluid management, regulate acid/base F & E, reduce tissue catabolism
Phases of ATN

**Diuretic**
- Indicates nephrons are healing
- 7-15 days; u/o increase; unable to concentrate urine or filter wastes
- Treatment: dialysis; F & E replacement

**Recovery**
- 3-12 months; ?residual dysfunction
- Treatment: supportive care, prevent further injury, dialysis, renal diet, fluid restriction, monitor
Clinical Manifestations

- **Lab**
  - Increase BUN/Cr; Hyperkalemia; Hyperphosphatemia; Hypocalcemia; anemia; thrombocytopenia

- **Assessment**
  - Neuro; CV; Pulmonary; GI; Skin; Immune
See handout comparing 3 types of renal failure and lab indicators
Treatment

Prevention
- Early detection – Identify patients at risk!
- Know causes
- Monitor VS, Labs, volume
- Avoid nephrotoxins
  - Decrease dose
  - Extend dosing interval
Treatment

- Nephrology consult
- Control volume status
- Control acid base balance
- Infection control
- Patient/family education
Treatment

- Treat the cause
- Treat system imbalances

Diet
- Adequate nutrition
- Low potassium
- Protein controlled
- Balance electrolyte/glucose needs
- Vitamin supplements
- Low sodium/heart healthy
Treatment

- Renal replacement therapies
- Indications – volume/electrolyte imbalances, acidosis, uremia – BUN >100 mg/dl, pericarditis
  - Hemodialysis
  - Peritoneal dialysis
  - Refer to handout
Contrast Induced Nephropathy

- Cause of ARF
- 3rd most common cause
- Diagnosis based on Cr post exposure
- Tests requiring contrast
- Pathogenesis unclear
Contrast Induced Nephropathy

Prevention

- Hydration – most effective
- Na Bicab and N-acetylcysteine
- Choice of contrast agent
- Avoid nephrotoxic medications
- Close assessment
Chronic Renal Failure

- Slow, progressive, irreversible damage to nephron, resulting in deterioration over months to years
Chronic Renal Failure

Causes

- Glomerular disease
- Vascular disease
- Interstitial nephritis
- Hereditary disease
- Obstructive diseases
- ARF

***DM; HTN; Glomerulonephritis ***
Chronic Renal Failure Stages

- Diminished renal reserve
  - Decreased number of functional nephrons

- Chronic Renal Insufficiency
  - Asymptomatic; BUN/CR increase

- End Stage Renal Disease
  - Symptomatic; ? dialysis

- Uremic Syndrome
  - Severe BUN/CR increase/ dialysis!!
Kidney Disease Outcome Quality Initiative

- Defined stages of failure r/t GFR
- Normal GFR 125-150 ml/min
- Kidney damage lasting 3 months or more
Chronic Renal Failure Stages

1 - Kidney damage with nl GFR > 90
2 – Kidney damage with mild decrease in GFR 60-89
3 – Moderate decrease in GFR 30-59
4 – Severe decrease in GFR 15-29
5 – Kidney Failure <15 (or dialysis)
Clinical Presentation

- History, precipitating factors
- PE
  - Uremic manifestations
  - Change in mental status
  - GI
  - CV
  - Skin
  - Hematologic
  - HTN/fluid overload
Clinical Manifestations

- Critical Care Nurse
- August 2006
- Figure 2, pg 23
- Chronic Kidney Disease
- Broscious, Castagnola
Mineral/Bone Issues in CRF

- Diminished Ca absorption in the gut
- Overproduction of parathyroid hormone r/t hyperphosphatemia
- Disordered Vitamin D metabolism
- Chronic metabolic acidosis
- These lead to bone resorption = osteomalacia and osteoporosis
Laboratory Findings

- Urinalysis
  - proteinuria, hematuria, casts

- Creatinine Clearance
  - 10-50ml/min in CRI
  - <10ml/min in ESRD

- KUB/US
  - Small kidneys

- Biopsy
Management

- Prevent infection
- Manage anemia/electrolyte imbalance
- Prevent tissue breakdown
- Renal Diet
- Maintain cardiac output
Management

- Dialysis
  - Requires access
- Medications
- Fluid restrictions
Access for hemodialysis

AV Fistula

- Permanent; created surgically-connect artery to vein; forearm most common
- Preferred route for dialysis – good blood flow/few problems/long lasting but needs to mature 3-4 months
Access for Hemodialysis

- **AV Graft**
  - Permanent; created surgically – synthetic material connected to artery and vein
  - Matures 3-6 weeks but higher incidence of thrombosis/stenosis than fistula; allergies

- **Catheter**
  - Temporary; usually inserted into IJ
  - No maturation but infection risk, decreased flow rates
QUESTIONS??

- Questions?
- Questions??
- Questions???
Clinical assessment findings in a patient with hypocalcemia include all of the following except:

A. Tetany
B. Increased CO
C. Bruising and bleeding
D. Positive Chvostek & Trousseau’s signs
Clinical assessment findings in a patient with hypocalcemia include all of the following except:

- B. Increased CO – it is decreased
Questions

Ms. Smith has had a CI <1.5 and a MAP <50 mmHg for the last 20 minutes. She is at risk for developing which type of renal failure?

- A. Pre renal
- B. Intra renal
- C. Post renal
- D. Both A and B
Ms. Smith has had a CI <1.5 and a MAP <50 mmHg for the last 20 minutes. She is at risk for developing which type of renal failure?

A. Pre renal
Questions

Which of the following interventions are appropriate for the newly diagnosed patient with pre renal oliguria?

- A. Restrict fluid and prepare for dialysis
- B. Give fluids and prepare the patient for X-ray
- C. Administer a fluid challenge and give diuretics
- D. Restrict fluids and give Kayexalate as ordered
Which of the following interventions are appropriate for the newly diagnosed patient with pre renal oliguria?

- C. Administer a fluid challenge and give diuretics
Questions

- Elevation of serum BUN is a reliable indicator of renal function
  - A. True
  - B. False
Answer

- Elevation of serum BUN is a reliable indicator of renal function

- B. False – Cr is more reliable
Mrs J is a 49 yo with IDDM and presents to the ER with fever of 102, nausea, weakness in her legs, and tingling in her fingers. She states she got the flu and hasn’t felt like eating. She doesn’t know her blood sugar and hasn’t been taking her insulin since she wasn’t eating.
Continued

The nurse notes a decreased level of consciousness – she arouses when her name is called. BP 94/52 HR 88, RR 28 (deep). Glucose 420. Tall peaked T waves are seen on the bedside monitor.

1. What is her problem?
2. Which electrolyte imbalance does she likely have?
3. How will you treat this?
Questions

ARF differs from CRF in that it:

- A. Results in higher BUN levels
- B. Has a higher mortality rate
- C. Requires PD
- D. Is associated with diabetes
Answer

ARF differs from CRF in that it:

- B. Has a higher mortality rate
Questions

The best dialysis for the patient with ARF is:

- A. Every other day
- B. Weekly
- C. Daily
- D. Bi-weekly
The best dialysis for the patient with ARF is:

- C. Daily
The primary etiology of hyperphosphatemia is:

- A. Over replacement
- B. Hypercalcemia
- C. Renal Failure
- D. Hypoalbuminemia
The primary etiology of hyperphosphatemia is:

- C. Renal Failure

NOTE: Read hyper/hypo very carefully
Questions

Bradycardia tremors and twitching muscles are associated with which electrolyte disorder?

- A. Hypokalemia
- B. Hyperkalemia
- C. Hypophosphatemia
- D. Hyperphosphatemia
Bradycardia tremors and twitching muscles are associated with which electrolyte disorder?

- B. Hyperkalemia
Questions

Treatment for hypercalcemia includes:

- A. Fluids and diuretics
- B. Amphogel
- C. Kayexelate
- D. Dialysis
Answer

Treatment for hypercalcemia includes:

- A. Fluids and diuretics
Hyponatremia is usually associated with:

- A. Over administration of NS
- B. Dehydration
- C. Diuresis
- D. Fluid overload
Answer

Hyponatremia is usually associated with:

- D. Fluid overload
Mr. S was involved in a motor vehicle accident and is experiencing hematuria. The best diagnostic test to evaluate renal trauma is:

- A. Ultrasound
- B. CT
- C. IVP
- D. Angiography
Mr. S was involved in a motor vehicle accident and is experiencing hematuria. The best diagnostic test to evaluate renal trauma is:

- B. CT
Which of the following is not an etiology of acute renal failure (ARF)?

- A. Sepsis
- B. Shock
- C. Bladder tumor
- D. Hypertension
Which of the following is not an etiology of acute renal failure (ARF)?

- D. Hypertension
Test Tips

- Renal is 8 questions/6% = so stick with the big stuff to study
- Read questions carefully
- Formulate your own answer
- Read questions carefully with hypo and hyper in them
- Read ALL choices and choose one
Test Tips

- Read question – not INTO the question
- Test is general knowledge – not once in a lifetime situation
- Exams are national certification = may be asked about things you don’t see in your unit = check the Blue print to study
Test Tips

- Minimal recall type questions
- Most are application types
- Concentrate study time on areas with largest sections of the test
- Seek out patient assignments in your needed area to assist with application and analysis level questions
Test Tips

Test item check list

- Read the stem
- Read the options
- Read the stem again
- Look for key words
- Eliminate the obviously incorrect options
Test Tips

- Safety first – when the stem asks what is essential to do – think safety
- Time frame – time related words like early or late are very important. Pay attention to these
Test Tips

- Make a dry run to the testing center

The Big Day

- Be careful of sugar
- Be careful of caffeine
- Protein for brain fuel
- Arrive early – sit and relax
- Maintain distance from “stress cadets”
Remember

- Study and prepare
- Focus and Think positive
- Become certified

Good luck!!
After the Exam

CELEBRATE
CELEBRATE
CELEBRATE
CELEBRATE
CELEBRATE
CELEBRATE