Bio217: Pathophysiology Class Notes
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Unit VIII: Urinary (Renal) System Disorders and Reproductive System Disorders

Chapter 28: Structure & Function of Renal & Urologic Systems
Chapter 29: Alterations of Renal & Urinary Tract Function
Chapter 31: Structure and Function of Reproductive Systems
Chapter 32: Alterations of the Reproductive Systems

Structures of Urinary System

- Kidneys (2)
  - Retroperitoneal
  - Renal capsule
  - Adipose capsule
  - Renal fascia
  - Hilum
- Ureters (2)
- Urinary Bladder (1)
- Urethra (1)

Structures of Urinary System

- Cortex
- Medulla
- Pyramids
- Calyces
  - Minor and major
- Renal pelvis

Structures of the Kidney

• 1.2 million nephrons per kidney
• Functional unit of the kidney
  - Cortical nephrons
  - Juxtamedullary nephrons
• Parts of nephron
  - Renal corpuscle (=____________________)
  - Renal tubules
    • Proximal tubule (pct)
    • Loop of Henle
    • Distal tubule (dct)

Nephron

• Glomerular filtration membrane
  - Blood passes through the three layers and forms the filtrate

Nephron
• Juxtaglomerular apparatus
  – Juxtaglomerular cells (→ renin)
  – Macula densa (sense changes in Na+)
  – Renin-angiotensin pathway: ____________
    • Decrease blood volume or decrease Na+ → increase renin →
    Angiotensin I → Angiotensin II → aldosterone
    (increase reabsorption of Na+ and H₂O)

Nephron

• Urinary Bladder
  – Detrusor muscle
  – Trigone
  – Micturition reflex

• Urethra
  – Internal and external sphincters
  – 3 to 4 cm in females
  – 18 to 20 cm in males

Structures of Urinary System

• Receive 1000 to 1200 mL of blood/min.
• Glomerular filtration rate (GFR)
• Autoregulation
  – Tubuloglomerular feedback

Renal Blood Flow

• Neural regulation

• Hormones
  – Renin-angiotensin system
  – Aldosterone
  – ADH (____________________________)
Renal Blood Flow

Nephron Function

• Filters plasma
• Reabsorbs and secretes
  – Tubular reabsorption and secretion
• Forms a filtrate of protein-free fluid
• Regulates filtrate to maintain fluid volume, electrolytes, and pH

Nephron Function

• Glomerular filtration
  – Net filtration pressure
    • Glomerular capillary oncotic/hydrostatic pressure
    • Bowman capsule oncotic/hydrostatic pressure
  – Filtration rate
    • ____________

Concentration and Dilution of Urine

• Countercurrent exchange system
  – Contributes to production of concentrated urine

Concentration and Dilution of Urine

• Aldosterone
• Antidiuretic hormone (ADH)
• Atrial natriuretic peptide (ANP)
  – produced by RA, when RA press. increases, inhibits secretion of renin
• Diuretics
  – ____________urine flow (by disrupting Na+ reabsorption and decr. ECF vol.)

Concentration and Dilution of Urine

• Urinary tract obstruction
  – interference with flow of urine at any site along urinary tract
  – Obstruction can be caused by anatomic or functional defect
  • Obstructive uropathy – changes in urinary system due to obstructions (anatomic)
Urinary Tract Infection (UTI)

• **UTI** - inflammation of urinary epithelium caused by bacteria
  • Acute cystitis
  • Interstitial cystitis
  • Acute and chronic pyelonephritis

**Urinary Tract Infection (UTI)**

**Acute cystitis**
- Cystitis is an inflammation of the u.b.
  - *E. coli* most common cause

  **Manifestations**
  - Frequency, dysuria, urgency, and lower abdominal and/or suprapubic pain

  **Treatment**
  - Antimicrobial therapy, increased fluid intake, avoidance of bladder irritants, and urinary analgesics

**Interstitial cystitis**
- Nonbacterial infectious cystitis

  **Manifestations**
  - Most common in women 20 to 30 years old
  - Bladder fullness, frequency, small urine vol., chronic pelvic pain
  - Immunocompromised (undergoing chemo or radiation therapy)

  **Treatment**
  - No single treatment effective, symptom relief

**Pyelonephritis**
- Acute pyelonephritis
  - Acute infection of the renal pelvis & interstitium
    - Vesicoureteral reflux (urine reflux up ureter into kidney), *E. coli, Proteus, Pseudomonas*

- Chronic pyelonephritis
  - Persistent or recurring episodes of acute pyelonephritis that leads to scarring
  - Risk of chronic pyelonephritis increases in individuals w/ renal infections and some type of obstructive pathologic condition

**Chronic Pyelonephritis**
**Glomerular Disorders**

- **Glomerulonephritis**
  - Inflammation of the glomeruli (typically after a strep infection)
  - Immunologic abnormalities (most common)
  - Drugs or toxins
  - Vascular disorders
  - Systemic diseases
  - Viral causes
  - Most common cause of end-stage renal failure

- **Mechanisms of injury**
  - Immune response - deposition of antigen-antibody complexes in glomerular capillaries
  - Formation of antibodies against the glomerular basement membrane → break down cells → incr. permeability

**Glomerulonephritis**

- **Acute poststreptococcal glomerulonephritis**
- **Rapidly progressing glomerulonephritis (RPGN)**
  - Antiglomerular basement membrane disease (Goodpasture syndrome) – rare
- **Chronic glomerulonephritis**

**Kidneys are small and have granular external surface**

**Uremia**

- = accumulation of N-wastes and metabolic toxins in plasma
  - Symptoms: confusion, GI complaints, fluid in lungs, infection
  - Describes clinical manifestations of CRF (chronic renal failure)

**Chronic renal failure (CRF)**

- Progressive, irreversible loss of renal function that affects nearly all organ systems

- **Stages**
  - Chronic renal insufficiency (GFR 20-35% of normal)
  - Chronic renal failure (GFR 20-25% of normal)
  - End-stage renal failure (GFR <20% of normal)

**Chronic Renal Failure**
• CRF due to:
  − Glomerulonephritis
  − Chronic infections (pyelonephritis or TB)
  − Congenital (polycystic disease)
  − Vascular (HT or nephrosclerosis)
  − Obstructions (renal calculi)
  − Diabetic neuropathy

Imbalances in following factors:
• Proteinuria and uremia
• Creatinine and urea clearance
• Fluid and electrolyte balance
  − Sodium and water balance
  − Phosphate and calcium balance
  − Potassium balance
  − Acid-base balance

• Alterations seen in following systems:
  − Musculoskeletal
  − Cardiovascular and pulmonary
  − Hematologic
  − Immune
  − Neurologic

− Gastrointestinal
  • Alteration in protein, carbohydrate, and lipid metabolism
− Endocrine and reproduction
− Integumentary

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  − Musculoskeletal
  − Cardiovascular and pulmonary
  − Hematologic
  − Immune
  − Neurologic

Concept Check

1. Which is an abnormal substance of urine?
   − A. Urea    C. NaCl
   − B. glucose D. Creatinine

2. The presence of albumin in urine would indicate damage to:
   − A. Glomeruli    C. pyramids
   − B. Collecting ducts D. None of the above

3. GFR is regulated by
   − A. ANS C. Renin-angiotensin system
   − B. ANF D. All of the above
4. An increase in permeability of the dct and cd is due to:
   - A. Decrease in ADH production
   - B. Increase in ADH
   - C. Decrease in blood plasma osmolality
   - D. Increase in water content in blood

5. UTIs occur:
   - A. Only in the kidneys
   - B. Anywhere but the kidneys
   - C. Anywhere in the urinary system

Matching:
6. acute cystitis  a. Infection of renal pelvis & interstitium
7. uremia        b. Inflam. that is most common cause of end-stage renal failure
8. glomerulonephritis c. Renal failure w/ elevated blood urea and creatinine
9. pyelonephritis d. U.b. inflam. ranging from hyperemic mucosa to necrosis of u.b. wall

Structure and Function of the Reproductive Systems
Chapter 31
&
Alterations of the Reproductive Systems
Chapter 32

Development of the Reproductive System
- Dependent on sex hormones
  - Males—testosterone
  - Females—estrogen, FSH, and LH

Female Reproductive System
- External genitalia (vulva)
  - Mons pubis
  - Labia majora
  - Labia minora
  - Clitoris
  - Vestibule

Internal Genitalia
- Vagina
- Uterus
  - Cervix
- Fallopian tubes
- Ovaries
Female Sex Hormones

- **Estrogens**
  - Estradiol (E2): 95% produced by ovaries
    - remainder by adrenal gland & placenta (pregnancy)
  - Estrone
  - Estriol
- **Progesterone** – from____________
- **Androgens** – small amt. from____________

Menstrual Cycle

- **Menarche**
- **Menopause**
- **Phases**
  - Menstruation (menses)
  - Follicular/proliferative phase
  - Luteal/secretory phase
  - Ischemic/menstrual phase
Menstrual Cycle

- Ovarian cycle
- Uterine phases
- Vaginal response
- Body temperature change
  - BBT (basal body temp.) biphasic
  - Follicular phase = ~98°F
  - Luteal phase ~ 0.4 -1.0 °F elevation

Male Reproductive System

- External genitalia
  - Testes
    - Produce gametes and sex hormones
  - Epididymis
    - Vas deferens
  - Scrotum
  - Penis
    - Glans and prepuce

Male Reproductive System

- Internal genitalia
  - Ducts
    - Vas deferens and ejaculatory duct
  - Accessory Glands
    - Seminal vesicles
    - Prostate gland
    - Bulbourethral glands

Spermatogenesis

- Spermatogonia
- Primary spermatocytes
- Secondary spermatocytes
- Spermatids
- Sertoli cells
  (Sustentacular cells)
Male Sex Hormones

- **Androgens**
  - Primary androgen—testosterone
  - Produced mainly in (_________________) of Leydig cells of testes
  - Testosterone
    - Sexual differentiation
    - Urogenital system dev.
    - Nervous and skeletal tissue dev.
    - Libido

Disorders of the Female Reproductive System

- **Hormonal and menstrual alterations**
  - **Primary dysmenorrhea** (________ menstruation)
    - Painful menstruation associated with prostaglandin release in ovulatory cycles
  - **Secondary dysmenorrhea**
    - Painful menstruation related to pelvic pathology (endometriosis, PID, fibroids)
  - **Pathophysiology**
    - Excess PGF from endometrium; GI upset, headaches, syncope
  - Treatment: Hormones, PG inhibitors, exercise, heat

Hormonal and Menstrual Alterations

- **Primary amenorrhea**
  - _________ of menstruation by age 14
  - (& no secondary sex characteristic dev. by age 16)
  - Pathophysiology:
    - Dysfunctional H-P-O axis; congenital or hypoplasia of uterus; genetic (Turner’s syndrome XO)
- **Secondary amenorrhea**
  - Absence of menstruation for three or more cycles or 6 months in women who have previously menstruated

Amenorrhea

- Normal ovarian hormone secretion
  - Pregnancy
  - Uterine dysfunction caused by
    - Menorrhagia
    - Uterine adhesions
- Decreased ovarian hormone secretion
  - Ovarian dysfunction caused by
    - Pregnancy
    - Menorrhagia
    - Menstrual bleeding disorders
  - Dysfunctional uterine bleeding
- Increased ovarian hormone secretion
  - Ovarian dysfunction caused by
    - Premature menopause
    - Hypothalamic-pituitary disorders
    - Hormonal imbalance, endocrine disease

Hormonal and Menstrual Alterations

- **Secondary amenorrhea**
  - Causes
    - Pregnancy (normal)
    - Dramatic weight loss
      - Malnutrition or excessive exercise
    - Anovulation
    - Hirsutism (increased testosterone)

Abnormal uterine bleeding

- Menstrual irregularity
- Dysfunctional uterine bleeding
Infection and Inflammation

- **Pelvic inflammatory disease (PID)**
  - Acute inflammatory disease due to _____________
  - May involve any organ of reproductive tract
  - Salpingitis (inflam. of _________ tubes)
  - Oophoritis (inflam. of _________)
  - STDs migrate from vagina to the upper genital tract
  - Polymicrobial infection (due to gonorrhea or chlamydia)

- Can lead to infertility, ectopic pregnancy, abscess, septic shock (death)

Pelvic Inflammatory Disease (PID)

- Salpingitis (inflam. of _________ tubes)
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Pelvic Inflammatory Disease (PID) (Salpingitis)

- Note: swollen fallopian tubes, adhesions on ovaries

Benign Growth and Proliferative Conditions

- **Endometriosis**
  - Presence of functioning _________ tissue or implants outside the uterus (retrograde menses)
  - Responds to hormone fluctuations of the menstrual cycle
  - Occur mostly in abdominal & pelvic cavities

Female Reproductive Cancer

- **Cervical cancer** (2% of cancers in women)
  - Cervical dysplasia (CIN – cervical intraepithelial neoplasia – precancerous)
  - Invasive carcinoma of the cervix

- **Risk factors**
  - HPV and HIV
  - Multiple sexual partners
  - Poor nutrition and smoking

- **Vaccine (2006)**
  - Gardasil (Merck) against HPV 6,11,16,18

- **Pap smear** – screening test
Cervical Cancer

A: progressive degrees of CIN
(cervical intraepithelial neoplasia)

B: Normal multiparous cervix

C: CIN Stage 1
(cancer only in cervix)

Female Reproductive Cancer

• Ovarian cancer (> 5% of all female cancer deaths)
• Cause — unknown; incr. risk with age, family history (breast or ovarian cancer)
• Pathophysiology:
  — Arise from epithelial cells (on outside of ovary, or stroma)
  — Associated with BRCA genes (breast cancer)
• Symptoms: abdominal pain & swelling (ascites)
• Metastasis: pelvis, colon, stomach, pleura

Disorders of the Testis

— Orchitis
  • Acute inflammation of the testis
  • Complication of a systemic disease or related to epididymitis
  • Mumps most common cause

Cancer of the testis

• Among the most curable of cancers (>95% cure)
• Common in men between ages 15 and 35
• Causes painless testicular enlargement
• Risk factors
  • History of Cryptorchidism (undescended testes)
  • Abnormal dev. of testes
  • Klinefelter (XXY)
  • History of testicular cancer

Disorders of the Prostate Gland

• Benign prostatic hyperplasia (BPH)
  — Enlargement of the prostate gland
  — Symptoms associated with urethral compression
  — Relationship to aging
  — Evaluation
    • Digital rectal exams
    • Prostate-specific antigen (PSA) monitoring

Cancer of the prostate

• Accounts for 29% of all cancers in males
• Prostatic cancer is asymptomatic until adv. stages
• Symptoms are similar to BPH
• Pathophysiology
  — 95% of neoplasms are adenocarcinomas
  — Related to steroid hormone use
  — T → DHT and estradiol (in animal studies: both → carcinogenic effect)
  — Action of IGF (insulin growth factor) potent mitogen (increase cell prolif. and decre. apoptosis)
  . Cancer cell lives and multiplies
Disorders of the Prostate Gland

- Cancer of the prostate
  - Dietary factors (high sat. fat, incr. calcium levels → decr. Vit. D which protects against prostate cancer, low fiber and complex CHO, incr. protein
  - Hormones (anabolic steroids)
  - Vasectomy (possibly due to elevated androgens, antisperm antibodies)
  - Chronic inflammation
  - Familial factors (5-10%)

Benign Breast Lesions

- Nonproliferative breast lesions
  - Fibrocystic changes (FCC)

- Proliferative breast lesions without atypia
  - Epithelial hyperplasia
  - Florid hyperplasia
  - Sclerosing adenosis
  - Complex sclerosing lesion
  - Papillomas

Breast Cancer

- Most common cancer in American women
- Leading cause of death from ages 40 to 44
- Second most common killer after lung cancer
- Black women more likely to die from it

Breast Cancer

- Reproductive factors (early 1st pregnancy lowers risk)
- Hormonal factors (ovarian androgen excess, HRT incr. risk)
- Environmental factors and lifestyle
  - Radiation
  - Diet (high intake fruits, veg., whole grains, low fat)
  - Chemicals (xenoestrogens — mimic estrogens, found in pesticides, plastics, detergents, drugs) (PCBs, DDT)
- Physical activity
- Familial factors and tumor-related genes

Breast Cancer

- Manifestations
  - Painless lump, dimpling of skin, edema

- Pathophysiology:
  - 70% arise from ductal (glandular) epithelium
  - Genetic alterations of DNA, chromosomes, suppression of apoptosis
  - 1/3 are hormone dependent (Progesterone or estrogen receptor positive)

- Treatment
  - Based on stage of cancer
  - Surgery, radiation, chemotherapy, hormone therapy, biologic therapy and bone marrow transplantation
Disorders of the Male Breast

- Gynecomastia
  - Overdevelopment of the breast tissue in a male
  - Results from hormone alterations
    - Idiopathic and system disorders, drugs, or neoplasms

- Male breast cancer
  - Most commonly seen after age 60
  - Tumors resemble carcinomas of breast in women
  - Crusting and nipple discharge are common clinical manifestations

Chlamydial Infections

- Chlamydia (bacterial)
  - Infections caused by Chlamydia trachomatis
  - Most common STI in the United States
  - Obligate, gram-negative, intracellular bacterium

Sexually Transmitted Urogenital Infections

- Syphilis
  - Treponema pallidum
    - Corkscrew-shaped, anaerobic bacterium that cannot be cultured in vitro
    - Infects any body tissue
    - Syphilis becomes a systemic disease shortly after infection.
      - Maternal-fetal transmission

Sexually Transmitted Viral Infections

- Human papillomavirus (HPV)
  - 120 different types of HPV
    - 30 serotypes are unique to stratified squamous epithelium
    - Divided into high-risk and low-risk serotypes
  - HPV is a nonenveloped, circular double-stranded DNA virus

Sexually Transmitted Parasitic Infections

- Trichomoniasis
  - Caused by T. vaginalis
    - Anaerobic, unicellular, flagellated, parasitic protozoan
  - Adheres to and damages squamous epithelial cells
    - Urethra, vagina, and Skene and Bartholin glands
  - Accounts for 25% of infectious vaginitis cases

Sexually Transmitted Viral Infections

- Genital herpes
  - Two serotypes
    - Herpes simplex virus type 1
    - Herpes simplex virus type 2
      - 80% of initial and 98% of recurrent infections are type 2
  - Transmitted through contact with a person who is shedding the virus in a secretion or from a peripheral lesion or mucosal surface
Sexually Transmitted Parasitic Infections

• Pediculosis pubis
  – Caused by the crab louse *Phthirus pubis*
  – Transmitted primarily by intimate sexual contact or contact with infected bed linens or clothing
  – A crab louse has a 25- to 30-day life cycle
    • Stages: egg or nit, three nymphal stages, and an adult stage

Sexually Transmitted Parasitic Infections

• Scabies
  – Caused by the adult female itch mite, *Sarcoptes scabiei*
  – Transmission of scabies requires prolonged close skin-to-skin contact
    • Typically occurs between family members or sexual partners

Concept CHECK

• 1. Progesterone
  – A. Stim. lactation
  – B. Incr. uterine tube motility
  – C. Thins the endometrium
  – D. Maintains the thickened endometrium

• 2. The ovaries produce
  – A. Ova, estrogens, oxytocin
  – B. Ova only
  – C. Ova and estrogens
  – D. Testosterone & semen

• 3. Cells that produce testosterone:
  – A. Interstitial cells
  – B. Testicular endocrine cells
  – C. Sustentacular cells
  – D. Spermatogonia

• 4. The function of testosterone:
  – A. Dev. Of male gonads
  – B. Bone and muscle growth
  – C. Influence sexual behavior
  – D. Growth of testes
  – E. All of the above

• 5. Acute PID
  – A. Mainly affects males
  – B. Is usually caused by viruses
  – C. Never causes peritonitis
  – D. May cause infertility or tubular pregnancy

• 6. Endometriosis
  – A. Has ectopic endometrium responding to changing hormone levels of the menstrual cycle
  – B. Occurs mainly in the pleural cavity
  – C. Causes infertility in most women
  – D. Does not occur after treatment

• 7. The infectious cause of orchitis is
  – A. Streptococci
  – B. Gonococci
  – C. Chlamydial organisms
  – D. Mumps virus