This PowerPoint file is a supplement to the video presentation. Some of the educational content of this program is not available solely through the PowerPoint file. Participants should use all materials to enhance the value of this continuing education program.

Nephrotic Syndrome

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Nursing I 32315
Nephrotic Syndrome Case Study

- Name: Alma Proteinia
- Occupation: florist
- Height: 5’1”
- Age: 50-year-old female
- Allergies: no known drug allergies
- Weight: 168 lbs.

Chief complaints:
- swollen hands and feet for 2 months
- puffy eyes for 1-2 weeks
- unable to fit into her shoes for 3 days
  - 18-lb weight gain in the last 6 weeks
  - blood pressure has increased from 148/88 to 178/98 in the last 6 weeks

- Objective assessment:
  - HEENT:
    - normocephalic
    - PERRLA
    - mild puffiness noted around her eyes*
    - no jaundice
    - red reflux bilaterally
    - eye grounds with mild arteriovenous nicking bilaterally*
    - throat is clear
    - thyroid is nonpalpable
    - midline trachea

- Health history: hypertension for 1 year
- History:
  - knee strain 6 weeks prior
  - treated with ibuprofen BID x10 days followed by OTC 200 mg 4-5 tabs BID
  - denies: ethyl alcohol or drug use

Nephrotic Syndrome Case Study

- Objective assessment:
  - chest (heart):
    - S1 and S2 are at a regular rate and rhythm
    - S4 is heard at the pulmonic area*
    - few scattered rales in the right lower lobe*
  - abdomen:
    - soft
    - BS (bowel sounds) present x4
    - no bruits
    - no organomegaly
    - hyperactive BS x4 quadrants*
    - no masses
    - no hernias
    - no costovertebral angle tenderness
  - extremities:
    - 4+ pitting pretibial edema extending to the knees*
    - hands too swollen to wear rings*

*probable findings secondary to nephrotic syndrome

BID: twice a day
OTC: over the counter
mg: milligrams
HEENT: head, eyes, ears, nose, throat
PERRLA: pupils equal, round, reactive to light and accommodation

S1: first heart sound
S2: second heart sound
S4: fourth heart sound
Defining Nephrotic Syndrome

- **Diagnosis:** NS (nephrotic syndrome)
- **NS definition:**
  - presence of proteinuria (>3.5 g [grams] in 24 hours) and subsequent hypoalbuminemia, which is found in conjunction with lipiduria, edema, and hyperlipidemia, as well as glomerular lesions or glomerular capillary wall injury
- **Two classifications exist:**
  - primary (idiopathic) – no known cause
  - secondary – underlying systemic cause

Normal Renal Function

Normal Glomerular Function

- Glomerulus is a collection of capillaries located at beginning of the nephron surrounded by the Bowman’s capsule
- Performs the initial filtration of blood to produce urine and dispose of wastes
- Glomerular filtration membrane surrounds the glomerular capillaries, creating a selective permeability based on size and electrical charge
- Normal function prevents protein and blood cell passage into the glomerular filtrate

Anatomy of the Glomerulus

- **Afferent arteriole** – carries blood from the interlobular arteries into the glomerulus
- **Efferent arteriole** – carries blood from the glomerulus to the peritubular capillaries
- **Bowman’s capsule** – surrounds the glomerulus; absorbs filtrate for further urine production/filtration in the nephron
- **Mesangial matrix** – mesangial cells surround and support glomerular capillaries
- **Glomerular filtration membrane** – selectively filters water/fluids/electrolytes from blood and plasma
  - **capillary endothelium** – fenestrated epithelium of glomerular capillaries
  - **basement membrane** – a negatively charged membrane between endothelium and epithelium
  - **visceral epithelium** – filtering epithelium cells

Glomerular Filtration Membrane

- The glomerular filtration membrane is composed of three layers:
  1. Glomerular capillary epithelium
     - produces vasodilators, vasoconstrictors, nitric oxide, and endothelin – which help regulate filtration rate
     - contains perforations (fenestrae) to allow for filtrate production
  2. Basement membrane
     - a negatively charged membrane; prevents the passage of negatively charged molecules into the filtrate
  3. Podocytes (visceral epithelium)
     - outer layer of the membrane with small slits – preventing the passage of large blood cells and proteins
     - produce nephrin, podocin, and CD2-associated proteins necessary for regulation of filtrate
Glomerular Filtration Rate

- GFR (glomerular filtration rate) is measured as filtration of plasma per unit of time
- Kidneys have developed compensatory mechanisms to protect the glomeruli, and maintain continuous GFR and fluid/electrolyte balance such as:
  - **autoregulation of GFR by the kidneys**: increased arterial pressure = vasoconstriction of arterioles, thus preventing an increased GFR
  - **myogenic regulation**: decreased arterial pressure causes relaxation of arterioles to maintain a constant GFR
  - **neural regulation**: innervated arterioles constrict with decreased arterial pressure to reduce renal blood flow and the GFR, therefore conserving fluid volume and electrolytes to increase arterial pressure
    - decreased blood volume stimulates norepinephrine to produce vasoconstriction in the afferent arterioles
- The GFR is controlled by the level of vascular resistance of glomerular arterioles, cardiac output, and oncotic pressure in Bowman’s space and the glomerular capillaries
- Glomeruli filters ~180 L/day (liters per day) of fluid
- 99% of filtrate is reabsorbed and returned to the blood

Glomerular Filtration Rate

- Oncotic pressure – osmotic pressure created by the plasma gradient
  - glomerular filtrate is normally mostly free of blood and plasma as seen with a minimal oncotic pressure
  - the loss of intracellular plasma protein into the extracellular space leads to edema due to fluid being pulled out of the vasculature into the tissue
- Vascular resistance providing the pressure needed for filtrate production is ~47 mmHg (millimeters of mercury)
  - multiple influences include:
    - adenosine
    - angiotensin II
    - atrial natriuretic peptide
    - B-type natriuretic peptide
    - bradykinin
    - nitric oxide
    - nephrin
- Each glomerulus has an afferent arteriole at its entry and an efferent arteriole at its exit
GFR and Vascular Resistance

- Vasoconstriction of the afferent arteriole leads to decreased blood flow and subsequently a decreased GFR, thus body fluids are conserved
- Vasoconstriction of the efferent arteriole leads to increased glomerular pressure and GFR
- Vasoconstriction of afferent and efferent arterioles leads to a reduced renal blood flow with a subsequent GFR decrease

Etiology and Pathology

- NS occurs when normal glomerular filtration is interrupted at the glomerular filtration membrane
- Two classifications exist with varying pathologies for each subtype:
  - primary (idiopathic) – no known cause
  - secondary – underlying systemic cause
- Most cases are idiopathic with an unknown cause
- Secondary NS has an underlying cause from conditions from either drugs or a systemic disease

Primary NS

- INS (idiopathic nephrotic syndrome)
  - unknown origin
  - different types
    - MCN (minimal change nephropathy)
    - FSGS (focal segmental glomerulosclerosis)
    - MN (membranous nephropathy)
    - MPGN (membranoproliferative glomerulonephritis)
- MCN
  - also known as lipoid nephrosis
  - an unknown mechanism of increased glomerular filtration membrane permeability, leading to albuminuria and lipoid deposits in the urine
  - visceral epithelium podocyte foot processes become fused
    - possibly caused by lymphocytes releasing permeability factors
  - the negative charge on the basement membrane is lost
    - albumin permeates the membrane, leading to albuminuria
    - the loss of protein prompts lipid synthesis from the liver with subsequent hyperlipidemia and hyperlipiduria
Primary NS

- **FSGS**
  - unknown etiology, but is more common in black children
  - findings include podocyte thinning with a subsequent increase in membrane slit size, thus causing an increased membrane permeability
  - glomerulosclerosis develops at the glomerular filtration membrane due to proliferation of the capillary endothelial and supportive mesangial cells – leading to renal dysfunction and end-stage renal disease
  - FSGS causes high risk for renal disease and a need for renal transplant

- **MN**
  - most common cause of NS in adults, although the underlying cause remains unknown
  - IG4 antibodies are deposited in every glomeruli basement membrane as a result of the renal antigen immune complement
  - mesangial cells and podocytes release inflammatory mediators causing basement membrane sclerosis
  - basement membrane sclerosis causes dysfunction and increased permeability, leading to proteinuria and subsequent NS

Primary NS

- **MPGN**
  - unknown cause
  - found most often in young adults and children – accounting for approximately 4% of primary renal causes of NS in children and 7% in adults
  - found with hypocomplementemia and is the main hepatitis C-associated nephropathy
  - glomerular immune complex deposits cause proliferation of mesangial support cells and subsequent thickening of the basement membrane, causing increased permeability, thus the deposits are at the intraglomerular mesangium
    - not to be confused with membranous glomerulonephritis where the basement membrane is thickened, but the mesangium is not
  - glomerular blood flow is restricted due to immune complex deposits in the capillary walls, which leads to decreased glomerular filtration
Primary NS

- Three types exist:
  - Type I (MPGN I)
    - type I is the most common by a large percentage and is due to immune complexes depositing in the kidney
    - characteristically, there are subendothelial and mesangial immune deposits
    - this is the type believed to be connected with the classical complement pathway
  - Type II (MPGN II)
    - sometimes referred to as “dense deposit disease” that is similar to type I
      - the difference is that this type is associated with the alternative complement pathway
    - spontaneous remissions of MPGN II are rare
    - approximately 1/2 of those affected will progress to end-stage renal disease within 10 years
    - can lead to the development of drusen, which is caused by the same deposits within the Bruch’s membrane beneath the retinal pigment epithelium layer of the eye
      - over time, vision can deteriorate and subretinal neovascular membranes, macular detachment, and central serous retinopathy develop
  - Type III (MPGN III)
    - very rare
    - characterized by a mixture of subepithelial deposits and the typical pathological findings seen in the type I disease
    - complement component 3 is seen under immunofluorescence

In summary, the three types include:
- MPGN I (type I): immune complex deposits in the subendothelium that lead to MPGN and NS
- MPGN II (type II): immune complex deposits found in the glomerulus capillary walls and membrane cells, as well as systemically in organs throughout the body, thus leading to the absence of immune complexes in the circulatory system
- MPGN III (type III) includes deposits found in the subendothelium (capillary wall) and subepithelium (visceral wall)
- MPGN can cause proteinuria, hematuria, NS, and acute or chronic kidney failure

Secondary NS

- Secondary NS has the same pathological findings as INS with underlying causes from:
  - drugs such as NSAIDs* (non-steroidal anti-inflammatory drugs), heroin, lithium, and gold
  - infections like HIV, hepatitis B and C, syphilis, strep throat, or mononucleosis
  - malignancies or immune disorders
  - systemic diseases including SLE (systemic lupus erythematosus), DM (diabetes mellitus), sickle cell anemia, multiple myeloma, and amyloidosis
Secondary NS: Causes/Etiologies

- The most common cause in children is minimal change disease
- Membranous glomerulonephritis is the most common cause in adults
- Additionally, this condition can occur from kidney disorders such as:
  - focal and segmental glomerulosclerosis
  - glomerulonephritis
  - mesangiocapillary glomerulonephritis
- NS can affect all age groups
  - in children, it is most common between ages 2-6
  - this disorder occurs slightly more often in males than females

Secondary NS

- NSAIDs
  - inhibit prostaglandin synthesis
  - prostaglandins:
    - normally mediate the inflammatory response
    - act as a vasodilator at arterioles to maintain hydrostatic pressure and GFR
  - decreased prostaglandins lead to increased T lymphocyte infiltration in mesangial matrix and subsequent glomerular membrane dysfunction
  - continuous NSAID use leads to renal failure due to altered hydrostatic pressure, GFR, and NS

Risk Factors

NS: Genetic and Metabolic Risk Factors

- High-risk haplotypes in the MYH9 (myosin heavy chain 9) gene:
  - seen as an underlying Mendelian disorder, which is a genetic disorder caused by abnormalities in genes or chromosomes
  - oligogenic and complex inheritance may account for a significant percentage of cases previously regarded as idiopathic
  - congenital genetic defect
- Additional risk factor: metabolic syndrome
  - increased adiponectin (the most abundant secretory protein of the adipose tissue in human plasma) is markedly increased in patients with NS
  - related to metabolic risk factors seen in endothelial dysfunction associated with metabolic syndrome
- Genes encoding proteins are highly expressed in podocytes, but also elsewhere in the glomerular capillary wall, unraveling the basis of NS and glomerular filtration barrier physiology
- Mutations in genes encoding nephrin, podocin, and PLCE1 (phospholipase C, epsilon 1) are responsible for most of the severe cases of congenital and early onset of NS
- Recessive mutations in this gene account for 42% of familial and 10% of sporadic cases of childhood-onset steroid-resistance nephrotic syndrome (SRNS), and have also been found in 39% of patients with congenital NS
**NS: Genetic Risk Factors**
- Mutation in the NPHS2 gene encoding podocin may lead to SRNS
- Alport syndrome: genetic defect of type IV collagen
- Congenital NS:
  - NPHS1, autosomal recessive gene mutation, restricts encoding of nephrin which leads to proteinuria
  - nephrin is a transmembrane protein in the epithelial podocytes of the glomerulus which helps control membrane permeability

**NS: Clinical Manifestations**
- NS is a group of symptoms that include protein in the urine, low blood protein levels, high cholesterol levels, high triglyceride levels, and swelling
- Swelling (edema) is the most common symptom; it may occur in the:
  - face and around the eyes (facial swelling)
  - arms and legs, especially in the feet and ankles
  - belly area (swollen abdomen)
- Other symptoms include:
  - foamy appearance of the urine
  - poor appetite
  - weight gain (unintentional) from fluid retention

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**NS: Clinical Manifestations**
- Periorbital edema*
  - first symptom in children
- Generalized edema (anasarca)*
  - caused by hypoalbuminemia, Na⁺ (sodium) retention, water retention, poor response to atrial natriuretic peptides, and increased aldosterone/ADH (antidiuretic hormone)
    - results in unintentional weight gain and skin stria (stretch marks)
- Pleural effusion and ascites
  - caused by hypertension and hypoalbuminemia
    - results in exertional dyspnea and fatigue*
- Proteinuria*
  - caused by increased glomerular permeability and decreased proximal tubule reabsorption
    - leads to edema and loss of immunoglobulins
- Hypoalbuminemia*
  - caused by a loss of protein through urine
    - leads to decreased plasma oncotic pressure and subsequent edema

*experienced by Alma*
**NS: Clinical Manifestations**

- **Hyperlipidemia**
  - caused by hypoalbuminemia, hepatic synthesis of very low-density lipoprotein, increased cholesterol, phospholipids, and triglycerides
  - results in increased risk of cardiovascular disease
  - is the hallmark of NS resulting from a decrease in catabolism and the increased synthesis of lipoproteins by the liver

- **Lipiduria**
  - caused by sloughing of oval fat bodies and hyperlipidemia
  - results in fat droplets in urine
  - *experienced by Alma*

- **Vitamin D deficiency**
  - caused by a loss of 1,25-vitamin D₃ transport globulin in the urine
  - results in a decreased intestinal calcium absorption and risk for bone pathology

- **Hypothyroidism**
  - caused by a urinary loss of thyroid hormone transport proteins and thyroid binding globulin
  - results in possible elevated thyroid stimulating hormone

**NS: Clinical Manifestations**

- **Hypercoagulability**
  - caused by alterations in clotting factors
  - results in increased risk for thromboembolic events
  - young adults are most at risk

- **Diarrhea and anorexia**
  - caused by mesenteric edema
  - results in malnourishment through protein deficiency
  - gastrointestinal symptoms are most common in children with NS

**Diagnostic and Clinical Tests**
Urological Diagnostic Tests and Findings

- Urinalysis
  - proteinuria:
    - urinary protein excretion of greater than 3.5 g/day is typical of NS
    - Alma’s 24-hour protein was 4.2 g/day
  - lipiduria:
    - fat droplets in urine
    - Alma’s urine was positive for oval fat bodies
  - glycosuria: glucose in the urine
  - hematuria: blood in the urine
  - aminoaciduria: amino acids in the urine
  - casts in the urine:
    - hyaline, fatty, or granular casts may be present

Serum Diagnostic Tests and Findings

- Albumin blood test
  - low serum albumin of 1-2.5 g/dL (deciliter)
    - normal: 3.4-4.8 g/dL
  - hypoalbuminemia is a characteristic (Alma’s albumin: 2.6 g/dL)

- Lipid panel (triglycerides, cholesterol, high-density lipoprotein, low-density lipoprotein, and very low-density lipoprotein)
  - decreased oncotic pressure from hypoalbuminemia stimulates compensatory hepatic lipoprotein synthesis, leading to an increase in serum lipids (dyslipidemia)
  - total cholesterol is commonly greater than 300 mg/dL (milligrams per deciliter) and often greater than 400 mg/dL
  - Alma’s triglycerides: 245 mg/dL
  - Alma’s cholesterol: 380 mg/dL

- Blood chemistry tests
  - basic metabolic panel or comprehensive metabolic panel
    - low blood protein levels, high cholesterol levels, and high triglyceride levels are expected
    - other findings may include elevated BUN (blood urea nitrogen) and creatinine
Serum and Urine Renal Function Assessment Diagnostic Tests

- Renal function tests
  - BUN
  - creatinine levels in serum
  - serum BUN/creatinine ratio
  - urine creatinine clearance
  - serum and urine osmolality
  - uric acid (serum and urine)

Renal Function Tests: BUN

- Major nitrogenous end product of protein and amino acid catabolism that is produced by the liver, and is distributed throughout the intracellular and extracellular fluid
- Urea nitrogen is excreted from the body primarily by the kidneys and a little by sweat or intestinal bacteria
- Kidneys – almost all urea is filtered out of the blood by glomerular function
- Some urea is reabsorbed with water
  - most is removed in urine
- Amount of urea excreted depends on the hydration of the patient
  - if the patient is dehydrated, then low tubular flow may exist → more urinary filtrate → more urea absorbed → high serum level
  - if overhydration occurs, then there is a high tubular flow rate and less is reabsorbed; therefore a low serum level is present
- Also can rise from renal and nonrenal factors
- Increased with high dietary protein intake or increased catabolism (corticosteroids therapy or muscle wasting disease)

Renal Function Tests: Elevated BUN

- Can be a prerenal, intrarenal, or postrenal problem
  - prerenal
    - poor renal blood flow like in shock or renal stenosis
    - impairment of perfusion slows filtration rate
  - intrarenal
    - damage to renal parenchyma
  - postrenal
    - obstruction in the kidney or urinary tract, which increases the tubular reabsorption of urea
    - BUN is used to evaluate renal function
    - with serum creatinine, it is used to monitor patients in renal failure

Renal Function Tests: Creatinine in Serum

- Creatinine is an amino acid and a waste product of protein metabolism
- Derived from creatine and is synthesized in the liver, kidneys, and pancreas
- Stored in the muscle tissue
- Creatinine is released into the extracellular fluid and excreted through the kidneys
- Creatinine is filtered by the glomeruli and NOT reabsorbed
- When the kidneys are working properly, serum creatinine is low
  - with renal function impaired, creatinine levels increase
- If half of the nephrons are damaged, then the serum creatinine level rises to about double
Renal Function Tests: Creatinine in Serum

- Normal creatinine levels:
  - men: 0.6-1.5 mg/dL
  - women: 0.6-1.1 mg/dL
  - pregnancy: reduced
  - children: 0.2-1.0 mg/dL (creatinine clearance is increased)

- Unlike BUN, serum creatinine is not affected by protein metabolism and minimally affected by hydration

Renal Function Tests: Creatinine in Serum; Nursing and Lab Indications

- Red-topped tube (venous, capillary, or arterial blood)
- Venipuncture must be smooth with an even blood flow, or excessive turbulence can cause abnormal false measurements

Renal Function Tests: Creatinine in Serum; Nursing and Lab Indications

- Red-topped tube (venous, capillary, or arterial blood)
- Venipuncture must be smooth with an even blood flow, or excessive turbulence can cause abnormal false measurements
- Elevated values:
  - acute and chronic renal failure
  - uremia
  - renal artery stenosis
  - CHF (congestive heart failure)
  - shock
  - rhabdomyolysis
  - acromegaly

- Decreased values:
  - advanced liver disease
  - long-term corticosteroid therapy
  - hyperthyroidism
  - muscular dystrophy
  - paralysis
- Instruct the patient to fast for 8 hours before test
  - ingestion of meat can cause a falsely elevated result
- Prolonged delay of specimen to the laboratory can cause ammonia to form and warming can cause falsely elevated results
- For infants and small children, a heel stick puncture is used to fill a capillary pipette
- Creatinine rises and falls more slowly than BUN levels
- It is the often preferred method for long-term assessment of renal function
**Renal Function Tests:** Creatinine Clearance Test

- The total amount of creatinine excreted in the urine in a 24-hour period is called creatinine clearance.
- During renal failure, diminished glomerular filtration occurs, thus increasing the secretion of creatinine.
- In chronic renal failure, uremia becomes very severe.
  - an eventual reduction occurs in the excretion of creatinine by both the glomeruli and the tubules.
- Decreases by 10% per decade after age 40 years, whereas serum creatinine shows little variation.
- Used to assess renal function and creatinine excretion.
- Used to monitor the progression of renal disease.

**Elevated values:**
- muscular dystrophy paralysis
- anemia
- leukemia

**Used to monitor the progression of renal disease**

**Elevated values:**
- hyperthyroidism

**Decreased values:**
- glomerulonephritis
- CHF
- acute tubular necrosis
- shock
- polycystic kidney disease
- dehydration

**Renal Function Tests:** Creatinine Clearance Test; Nursing and Lab Indications

- Can be shortened to 4 or 12 hours, but the best is 24 hours.
- Needs to be refrigerated or placed on ice.
- Instruct the patient to:
  - avoid excessive intake of meat before the test.
  - encourage adequate hydration before urine test.
  - omit coffee and tea.
- Usually instruct patient to void at 8:00 a.m., then all subsequent urine specimens are collected for 24 hours.
- No vigorous exercise.
- Label container with the proper time and date.
- Normal:
  - male: 1-2 g/day
  - female: 0.8-1.8 g/day.
Renal Function Tests: BUN to Creatinine Ratio

- Creatinine is changed only by renal dysfunction, thus a comparison of BUN with serum creatinine is helpful.
- Normal ratio is 10-15:1, but will vary based on protein intake and muscle mass.
  - an increased ratio will be present if the patient is dehydrated and creatinine does NOT change (25:1).
  - a decreased ratio will be present in low protein diet, overhydration, or severe liver disease (8:1).
  - both measures are also useful for monitoring nephrotoxic drugs (i.e., gentamicin and tobramycin).

Renal Function Tests: Serum Osmolality

- Osmolality is a measure of the number of particles dissolved in a solution.
- In blood, osmolality is created by protein, glucose, chloride, sodium, bicarbonate, and urea dissolved in the plasma.
- Osmolality is affected by increases or decreases in fluid volume, or by an increase or decrease in blood particles.
  - used to assess the patient’s fluid status and identify any ADH abnormalities.
- Normal:
  - adults: 285-298 mOsm/kg (milliosmoles per kilogram).

Renal Function Tests: Serum Osmolality

- Increased values:
  - alcoholism
  - aldosteronism
  - diabetes insipidus
  - high protein diet
  - dehydration
  - hypercalcemia
  - hyperglycemia
  - hypernatremia
  - hyperkalemia

- Decreased values:
  - fluid overload
  - hyponatremia
  - liver failure with ascites
  - Addison’s disease

- Four interfering factors:
  1. medications
  2. diuretics
  3. hemolysis of specimen
  4. mineralocorticoids

Renal Function Tests: Urine Osmolality

- Collected from a 24-hour urine specimen or 10 ml (milliliters) sample.
- Normal: 500-800 mOsm/kg of water.
- Urine osmolality varies based on the patient’s fluid status and metabolic waste products being excreted.
  - overhydrated: urine osmolality decreases as output increases.
  - dehydrated: urine osmolality increases as the output decreases.
Renal Function Tests: Urine Osmolality

- Urine osmolality is based on:
  - concentration ability of kidneys
  - serum levels of:
    - protein
    - urea
    - glucose
    - sodium
    - bicarbonate
    - chloride

- The purpose is to assess the ability of the kidneys to dilute or concentrate urine, and identify ADH abnormalities

- Increased values:
  - dehydration
  - Addison’s disease
  - DM
  - diarrhea
  - hyperglycemia
  - hypernatremia
  - cirrhosis

- Decreased values:
  - overhydration
  - hyponatremia
  - hypocalcemia
  - aldosteronism
  - diabetes insipidus

Renal Function Tests: Serum Uric Acid

- Uric acid is the end product of protein metabolism and excreted by the kidneys and bowels

- Normally, 2/3 of uric acid is excreted by the kidneys, and the other 1/3 by bile and intestinal secretions

- Temporary increases in serum uric acid from ingestion of food high in purine (meat and fish), strenuous exercise, or heavy alcohol ingestion will usually return to normal within 1 day

- Normal:
  - male: 3.6-8.5 mg/dL
  - female: 2.3-6.6 mg/dL

- The purpose is to confirm the diagnosis of gout, and help detect renal impairment that causes prerenal azotemia and renal failure

- Four interfering factors:
  1. starvation
  2. caffeine
  3. vitamin C ingestion
  4. high purine diet

- Elevated values:
  - gout
  - shock
  - polycystic kidney disease
  - renal failure
  - diabetic ketoacidosis
  - leukemia
  - lead poisoning
  - polycythemia vera
  - acute alcohol ingestion
  - psoriasis
  - pernicious anemia
  - toxemia of pregnancy

- Decreased values:
  - Hodgkin disease
  - multiple myeloma
Renal Function Tests: Urine Uric Acid

- This is the end product of protein metabolism, uric acid, and urate crystals excreted by the kidneys
- Purpose of test:
  - urinary excretion of uric acid in patients with renal calculi or those at risk for development of calculus
  - to assess the effect of enzyme deficiency or metabolic abnormality that results in the overproduction of uric acid
- Normal: 250-750 mg in a 24-hour specimen

Renal Function Tests: Urine Uric Acid; Nursing and Lab Indicators

- Elevated values:
  - gout
  - viral hepatitis
  - leukemia
  - Crohn’s disease
  - polycythemia vera
- Decreased values:
  - chronic glomerulonephritis
  - collagen disease
  - lead toxicity
- Interfering factors:
  - high or low purine diet
  - many medications (e.g., aspirin, anti-inflammatory drugs, diuretics, vitamin C)
  - failure to collect all urine
  - failure to store properly
- Specimen must be refrigerated or placed on ice
- A list of all medications taken by the patient should be noted

Other Serum Diagnostic Tests and Findings

- Other serum laboratory values common to NS:
  - an increase in serum phospholipids
  - decreased serum globulins and other proteins (e.g., serum ceruloplasmin, complement, transferrin) cortisol-binding globulin, and some coagulation factors may be decreased in the blood
  - albumin/globulin ratio is decreased or reversed
  - thyroid function tests
    - total T₄ (thyroxine) may be decreased as a result of decreased thyroxine-binding globulin
    - thyroid function is normal (normal free T₄)
  - serum protein electrophoresis may reveal diminished albumin and elevated alpha-2 globulin fraction
  - transferrin, cortisol-binding globulin, and some coagulation factors may be decreased in the blood
  - clotting factors V and VIII may be increased – predisposing the patient to thromboembolic events
- Tests to rule out various causes may include the following:
  - antinuclear antibody
  - cryoglobulins
  - complement levels
  - glucose tolerance test
  - hepatitis B and C antibodies
  - HIV test
  - rheumatoid factor
  - serum protein electrophoresis
  - syphilis serology
  - urine protein electrophoresis
**Imaging Studies:** Diagnostic Tests and Findings

- Renal ultrasonography may help to identify renal venous thrombosis
  - generally indicated, only if suggestive symptoms are present (e.g., flank pain, hematuria, acute renal failure)
- Radiographic studies are generally not indicated unless neoplastic etiology is suspected

**Other Invasive Diagnostic Tests and Findings**

- Renal biopsy (needle aspiration of kidney tissue)
  - often recommended to:
    - determine the subtype of the disease
    - assess disease activity
    - confirm the diagnosis of other predisposing diseases (i.e., amyloidosis or SLE)
  - possibly helpful in determining the benefit from corticosteroid therapy
  - no clear guidelines on the use of biopsy or on the timing of biopsy during diagnostics
  - no recent evidence showing definite benefit from biopsy, but it may lead to identification of the cause – even if the treatment remains the same

**Treatment Goals**

- To control NS, you must treat the disorder that is causing it
- One may need treatment for life
- The goals of treatment are to:
  - relieve symptoms through symptomatic treatment
  - prevent complications and induce remission
  - preserve renal function while delaying kidney damage

**NS Treatment**

- Hyperlipidemia and lipiduria
  - treat high cholesterol to reduce the risk of heart and blood vessel problems like atherosclerosis
  - a low-fat, low-cholesterol diet is usually not very helpful for people with NS
  - medications to reduce cholesterol and triglycerides (usually statins) may be needed
- Fluid retention and edema
  - fluid/sodium restriction is paramount for reduction of edema
  - a low-salt diet may help with swelling in the hands and legs
  - diuretics may also help with this problem
- Proteinuria, pleural effusion, ascites, anasarca, and hypoalbuminemia
  - maintain serum albumin level
  - low-protein diets may be helpful
  - eating a moderate-protein diet (1-2 g/kg/day)
NS Treatment

- Diarrhea and anorexia
  - maintain a positive nitrogen balance
  - adults should consume 35 kilocalories/kg/day
  - children should consume 100-150 kilocalories/kg/day
- Vitamin D deficiency, malnutrition, and anemia
  - supplement potassium, vitamin D, iron, and zinc, if NS is long term and not responding to treatment
- To prevent complications and induce remission:
  - corticosteroids provide immunosuppression and anti-inflammatory properties
    - corticosteroids and other drugs that suppress or quiet the immune system
    - corticosteroids are primary pharmacologic therapy in children
    - Rituximab® (B-cell antibody) is used for patients resistant to corticosteroid therapy
    - may prevent thrombosis by decreasing inflammation
- ACE (angiotensin-converting enzyme) inhibitors or ARBs (angiotensin receptor blockers)
  - keep blood pressure at or below 130/80 mmHg to delay kidney damage
  - ACE inhibitors or ARBs are the medicines most often used
  - ACE inhibitors may also help decrease the amount of protein lost in the urine
  - used often, even in normotensive patients

NS Pharmacologic Therapies

- Keep blood pressure ≤130/80
- ACE inhibitors or ARBs
  - lower blood pressure
  - reduce proteinuria
  - prevent thrombosis
  - used often, even in normotensive patients
- Antineoplastics and alkalinizing agents
  - used in chronic recurrent minimal change disease, rapidly progressing and membranous glomerulonephritis, and SLE
- Symptomatic treatment
  - intravenous albumin
    - increases plasma oncotic pressure
    - reduces edema and prevents hepatic lipoprotein synthesis
  - diuretic medications: mainstay medical management
    - remove excess water
    - loop diuretics are most beneficial
    - usually intravenous administration is necessary secondary to intestinal edema/poor oral medication absorption
    - thiazide, potassium sparing diuretics, or metolazone (Zaroxolyn®) may be used adjunctively with loop diuretics
Nephrotic Syndrome

If you have any questions about the program you have just watched, you may call us at: (800) 424-4888 or fax (806) 743-2233. Direct your inquiries to Customer Service. Be sure to include the program number, title and speaker.