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COURSE TITLE: RENAL PHYSIOLOGY, BODY FLUID & TEMPERATURE REGULATION AND AUTONOMIC NERVOUS SYSTEM.

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ASSIGNMENT: DISCUSS THE RENAL HANDLING OF GLUCOSE AND ELECTROLYTES.

DICUSS THE PHYSIOLOGY OF MICTURITION

THE RENAL HANDLING OF GLUCOSE: the kidney contributes to glucose

homeostasis through processes of gluconeogenesis, glucose filtration, glucose reabsorbtion and glucose consumption. The kidney is responsible for up to 20% of glucose production through the process of gluconeogenesis. Under normal circumstances, up to 180g/ day of glucose is filtered by the renal glomerulus and virtually all of it is subsequently reabsorbed in the proximal convoluted tubule. This reabsorption is effected by two sodium-dependent glucose contransporter (SGLT) protein. SGLT2 situated in the S1segment, is a low-affinity high-capacity transporter reabsorbing up to 90% of filtered glucose SGLT1, situated in the S3segments, is a high-affinity low capacity transporter reabsorbing the remaining 10% . In patients with T2DM, renal reabsorptive capacity maldaptively increases from a normal level of 19.3 to 23.3 mmol/l/min. The maintenance of glucose homeostasis is vital to preserve a constant source of glucose to the brain, the brain is an organ that uses glucose as it's principal metabolism fuel. Despite wide variation in glucose influx and efflux, plasma in healthy individuals, is situated and achieved by a well-coordinated system of hormones, neural pathways and glucose transport proteins that regulate dietary glucose absorption, renal glucose loss and endogenous glucose production in combination with glucose uptake and release by peripheral tissues. The kidney performs a distinctive role in

glucose homeostasis. Not only is it involved in glucose utilization but it is also increasingly recognized as having a significant role in gluconeogenesis and uniquely contributes to plasma glucose regulation by controlling glucose reabsorption from renal tubules following glomerular filtration.

THE RENAL HADLING OF ELECTROLYTE: some electrolytes that regulate renal functioning are sodium, potassium, phosphorus, calcium, magnesium. Electrolytes are particles that carry an electric charge when they are dissolved in blood. The kidneys help to maintain electrolyte concentration by regulating its concentrations in the body. Any disturbance in this process often leads to an electrolyte imbalance. Renal failure is often complicated by elevated potassium, phosphate and magnesium & decreased sodium and calcium. The kidney helps maintain electrolyte concentration by filtering electrolytes and water from blood, returning some to the blood and excreting any excess into the urine. Thus, the kidney help maintain a balance between daily consumption and excretion of electrolyte and water. Electrolyte abnormalities are very common in kidney disease states for one simple reason which is the fact that the kidney has a typical central role in maintaining normal levels of most electrolytes. Therefore, the abnormalities are a consequences of abnormal kidney function.

Sodium: sodium plays an important role in the body by maintaining fluid balance. Its major function is in the nerve and muscle function. The body obtains sodium from food and drinks and loses it in sweat and urine. When the kidney is functioning normally, it maintains a consistent level of sodium by adjusting the amount excreted from the body. When sodium intake and excretion are not in balance, it may lead to either high sodium (hypernatremia) or low sodium (hyponatremia).

Potassium: potassium is necessary for the normal functioning of cells, nerves and muscles. Potassium is obtained from food and drinks and lost primarily in urine but also through the digestive tract and in sweat. Imbalance in potassium can lead to high potassium (hyperkalemia) or low potassium (hypokalemia)

Phosphorus: in the body, almost all phosphorus is combined with oxygen to form phosphate. Phosphate is used as a building block for many substances such as DNA, cell membrane etc. The body obtains phosphate from food and excretes it in urine and sometimes stool. Foods that are phosphate rich are milk, egg yorks, chocolate and soft drinks. Imbalance in phosphate may be too high (hyperphosphatemia) or too low (hypophosphatemmia).

Calcium: calcium has many functions which include formation of bone, formation of teeth, muscle contraction, normal functioning of enzymes, blood clotting and maintenance of normal heart rhythm. The level of calcium in the blood is maintained by 2 hormones (parathyroid hormone(PTH) and calcitonin). The body moves calcium out of bones into the blood to maintain calcium levels. PTH increases the calcium level in blood whereas calcitonin is responsible for lowering calcium level in the blood. Too much calcium is called hypercalcemia and too little calcium is called hypocalcemia.

Magnesium: magnesium is required for the formation of bone and teeth and for normal functioning of nerves and muscles. Too much magnesium is called hypermagnesium and too low magnesium is called hypomagnesium.

PHYSIOLOGY MICTURITION

Micturition (urination) is the process of eliminating organic waste products which are produced as a result of cell metabolism in the body. Micturition is known as volding of the bladder. The process of micturition is regulated by the nervous system, muscles of the bladder and urethra. The urinary system also regulates the concentration of sodium, potassium, chloride

and other ions in the blood as well as helping to maintain normal blood pH, blood pressure and blood volume. The urinary bladder can store around 350-400ml of urine before it expels it out. Micturition is more than a simple reflex because it can be controlled by humans. The rate of micturition can be increased by contraction of abdominal muscles and by the performance of the Valsava's manoeuvre. Contraction of the strong pelvis floor muscles can stop urine in mid-flow. The sound or running water can help in micturition but some people cannot urinate in the presence of others, no matter how great the need . After micturition, less than 10ml of urine remains in the bladder and the cycle begins again. The process of the bladder releasing urine is known as stress-relaxation phenomenon. Some conditions like renal stones, inflammation and an enlarged prostate gland may all obstruct the flow of urine and may result in frequency of micturition and retention of urine. Bladder tumours and pregnancy also reduce normal bladder capacity. Environmental and psychological factors can also affect a patient's ability to pass urine.

Formation of urine

There are two kidneys which are bean-shaped and are approximately 10cm long, 5.5cm wide and 3cm thick. Each kidney weighs about 150g and has a marked indentation medially- the hilus where the renal artery and renal

nerves enter and the renal vein and ureter leave. Between them, the kidney make approximately 30ml or more urine every hour. Approximately 25percent of the cardiac output goes to the kidney where organic waste products are removed in the million nephron in each kidney. normal urine production, therefore depends on normal blood flow to the kidneys. The nephron is the functional unit of the kidney. Nephron permits the passage of some substances out the body but restrict the passage of others, for examples blood cells and large proteins.

Filtration: as blood flows through the glomerulus, much of the fluid and waste product in the blood are forced out through the walls of the capillaries, filtered and then flow into the bowman's capsule. The bowman's capsule surrounds the glomerul. This glomerular filtrate consist of water, potassium and urea. Urea is the most abundant waste product excreted by the kidney and is formed from ammonia, a highly toxic substance. Ammonia is formed in the liver from the breakdown of amino acids.

Absorption: much of the filtrate of the glomerulus includes water so it is reabsorbed into the capillaries surrounding the proximal & distal convoluted tubule, the loop of henle and the collecting tubule. All the glucose will be reabsorbed unless blood glucose levels are high, in which

glucose will be excreted in the urine. Sodium is also reabsorbed but the amount varies depending on how much the body requires to maintain a constant concentration of sodium ions in the blood.

Secretion: this is the final stage of urine formation, it occurs in the distal convoluted tubule and collecting tubules. The substances either diffuse or are actively transported out of the capillaries and into the collecting tubules to be excreted in the urine. Hydrogen ion, potassium ion, ammonia and some drugs are also secreted at this stage and the kidney plays an important role in maintaining the acid-base balance within the body.

The final composition of urine is as a result of filtration, absorption and secretion by the nephrons. The kidney produces an average of one and half liters of urine each day. The urine passes from the kidney to the bladder through the ureters where it is stored until it is eliminated via the urethra. The urine is then stored in the bladder, the bladder is a hollow, muscular sac which sits in the pelvis. In males, the base of the bladder lies between the rectum and pubic symphysis while in females the base is below the uterus and anterior to the vagina. The bladder stores approximately one liter when full. The opening described as the neck of the bladder which is between the bladder and the urethra is closed by two rings of muscles. These rings of muscles are closed by contraction, it remains contracted

except during micturition when they are relax.

CLINICAL CONDITIONS

Many clinical conditions can causes disturbance to normal urination including :

- Urinary incontinence: the ability to hold urine.
- Urinary retention: the inability to initiate urination.
- Overactive bladder: a strong urge to urinate usually accompanied by detrusor overactivity.
- Interstitial cystitis: a condition characterized by urinary frequency, urgency and pain.
- Prostatitis: an inflammation of the prostate gland that can cause urinary frequency, urgency and pain.