Lab Value Interpretation for Nurses: Chemistries and Renal Studies

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PURPOSE & OBJECTIVES

The purpose of this continuing education module is to provide nurses with the knowledge and skills to recognize changes in common chemistry and renal lab values. Additionally, after completing this module, you will be able to discuss reasons why these common lab values may be either elevated or decreased.

Objectives:

1. Define the normal ranges for the key chemistry values described in this course.
2. Name one reason for an increase or decrease in the key chemistries.
3. Define the difference between the two key lab values related to renal function
4. Describe how creatinine clearance values in combination with BUN and creatinine outline the renal function of an individual.
5. Name 2 key parts of the urinalysis and what they test for.

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INTRODUCTION

RN. Com is presenting a series of courses on lab values. Evaluation of labs by nursing staff is a critical function. Although the reports we receive often indicate high or low values, understanding the true meaning of these values in the context of the patient's condition, history and other factors is critical to safe care of the patient.

In this first part of the series, we will cover common chemistry values and renal function studies. These two types of labs are often grouped together to give a basic overview of the status of the patient, excluding issues surrounding hematology. These basic tests and their interpretation should be familiar to all nurses. Common chemistry values that this course will review include: sodium (NA), chloride (CL), potassium (K), calcium (CA), magnesium (MG), phosphate (P), carbon dioxide (CO2), serum osmolality, glucose and hemoglobin A_{1C}, (Hgb A_{1C}). BUN, Creatinine, and Creatinine Clearance will also be discussed. The common urinalysis will be reviewed at the conclusion of the course.

CHEMISTRIES

Sodium (NA)

Normal Range: 135-146 mEq/L

Sodium is the most abundant cation (positively charged ion) in the extracellular fluid and the chief base of the body. It functions in the body to maintain osmotic pressure, acid-base balance, and to transmit nerve impulses. Some nurses find it easier to think of the net sodium content of the body as fixed and the water content of the body as variable. This way, interpretation of abnormal sodium values focus on determining the cause of abnormal water volume. Since sodium is reported per liter of plasma water, when a sodium value is abnormal, you must determine if it is the sodium that is altered or the body's water content is altered (Traub, 1996).

Causes of *Hyponatremia* (associated with low total body sodium)	**Causes of *Hyponatremia* (associated with normal total body sodium) *AKA Euvolemic or dilutional hyponatremia***	**Causes of *Hyponatremia* (associated with high total body sodium)**
• Rapid infusion of hypotonic solution (dilutional) • Fluid replacement with D5W (dilutional) • Vomiting and/or diarrhea • Intravascular losses due to burn, peritonitis, pancreatitis • Hypoaldosteronism (Addison's Disease) • Aggressive diuresis • Hyperglycemia & mannitol infusions (due to osmotic diuresis)	• Any mechanism which enhances ADH secretion or potentiates its action in the collecting tubules of the kidneys • Glucocorticoid deficiency • Severe hypothyroidism • Administration of water to a patient with impaired water excretion capacity • SIADH (syndrome of inappropriate anti-diruetic hormone) • Drugs that increase ADH secretion (carbamazapine, chlorpropamide, chlofibrate, diuretics, narcotics, nicotine, vincristine) • Drugs that have ADH-like action or potentiate ADH renal effect (acetaminophen, ADH analogs, chlorpropamide, cyclophosphamide, diuretics, non-steroidal anti-inflammatory drugs –NSAIDS-)	• Edematous states such as CHF, cirrhosis, nephrotic syndrome, chronic renal failure

(Traub, 1996)

Causes of *Hypernatremia* (associated with low total body sodium)	Causes of *Hypernatremia* (associated with normal total body sodium) *AKA Euvolemic hypernatremia*	Causes of *Hypernatremia* (associated with high total body sodium) *Least Common*
• Impaired thirst mechanism • Hypotonic fluid losses (profuse sweating, diarrhea)	• Increased insensible water loss (Fever, extensive burns, mechanical ventilation) • Central and nephrogenic diabetes insipidus	• Exogenous administration of high-sodium containing fluids • Resuscitative efforts using hypertonic sodium bicarbonate • Inadvertent IV infusion of hypertonic sodium solutions • Inadvertent dialysis against high-sodium containing solution • Sea-water near drowning • Primary hyperaldosteronism • Cushing's disease

(Traub, 1996)

Chloride (CL)

Normal Range: 96-106 mEq/L

Chloride is the most abundant anion (negatively charged ion) in the extracellular fluid. Chloride is influenced by the extracellular fluid balance and acid-base balance. Chloride passively follows water and sodium. Chloride is typically used as a confirmation of a water or acid-base imbalance in the body. Chloride increases and decreases as sodium increases and decreases – except when your patient is experiencing significant GI losses. Chloride can be three times more abundant in the stomach than sodium. So when your patient is on acid-suppression therapy (i.e. cimetidine or omeprazole), has a nasogastric tube or is excessively vomiting, you may see a lower than normal chloride in the presence of a normal sodium (Sherwood, 1997 & Traub, 1996).

Causes of *Hyperchloremia*	Causes of *Hypochloremia*
• Salt and water retention (corticosteroids, guanethidine, NSAIDs) • Acetazolamide • Parenteral nutrition • Metabolic or respiratory acidosis (increased renal retention) • Interstitial renal disease (obstruction, pyelonephritis, analgesic neuropathy) • GI: Bicarbonate loss (cholera, staphylococcus infections of the intestines) • Bromide toxicity (false elevation)	• Acid suppression therapy • Nasogastric tube suction • Excessive vomiting • Gastric outlet obstruction • Metabolic alkalosis (increased renal excretion)

(Traub, 1996)

Potassium (K)

Normal Range: 3.5-5.0 mEq/L

Potassium is the major cation in the intracellular space. Potassium regulates muscle and nerve excitability. Other less known roles includes regulation of intracellular volume, protein synthesis, enzymatic reaction and carbohydrate metabolism (Oh & Carroll, 1994 & Zull, 1989). Although potassium influences muscle contraction and nerve excitability all over the body, the potential for life threatening cardiac arrhythmias make altered potassium values very concerning.

Causes of *Hyperkalemia*	Causes of *Hypokalemia*
• Extracellular shifting of potassium (metabolic acidosis) • Increased exogenous intake (salt substitutes, drugs such as penicillin potassium) • Increased endogenous intake (hemolysis, rhabdomyolysis, muscle crush injuries, burns) • Decreased output of potassium due to chronic or acute renal failure • Decreased potassium output due to drugs (potassium-sparing diuretics, angiotension-converting enzyme inhibitors, NSAIDs, B-adrenergic agonists, heparin, trimethoprim) • Deficiency of adrenal steroids • Addison's disease	• Intracellular shifting of potassium (alkalosis, B-Adrenergic stimulation, Insulin) • Decreased intake (alcoholism, potassium free IV fluids, anorexia nervosa, bulimia) • Increased output due to extrarenal causes (vomiting, diarrhea, laxative abuse, intestinal fistula) • Increased output of potassium due to renal causes (corticosteroids, amphotericin B, diuretics, hyperaldosteronism, Cushing's syndrome, licorice abuse)

(Sherwood, 1997 & Traub, 1996)

Calcium (CA)

Normal Range: 8.5-10.8 mg/dl

Calcium plays a key role in neuromuscular excitability, muscle contraction, regulation of endocrine functions, blood coagulation, and bone and tooth metabolism. Only a fraction of calcium is found outside of the bones. Only 0.5% of the body's total calcium is found extracellularly and exists in three forms: Complex bound (small amount), protein bound (mostly albumin), and ionized or free. The equilibrium among these three forms of calcium determines the overall homeostasis of calcium.

Certain factors influence the amount of calcium in the body. Vitamin D is important for the intestinal absorption of calcium, PTH-induced movement of calcium from the bone and calcium re-absorption in the kidneys, and parathyroid hormone (PTH). Calcitonin, secreted by the thyroid gland, inhibits bone and kidney re-absorption of calcium, and is a common treatment for hypercalcemia. PTH is secreted by the parathyroid glands in response to low serum-ionized calcium – generally working to increase serum calcium. Finally, the most important determinant of ionized calcium is the amount of calcium that is protein-bound – especially to albumin. The normal serum calcium is 8.5-10.8 g/dl for patients that have a normal albumin (4.0 g/dl). For patients you have a low serum albumin, the normal range of calcium must be corrected based upon their serum albumin concentration. You may use the following formula to determine the corrected calcium in patients with hypoalbuminemia:

$$\mathbf{CA_{corrected} = [(4.0\text{-}albumin)\ X\ 0.8\ mg/dl] + CA_{uncorrected}}$$

For example, you may be administering parenteral nutrition to a cachectic patient whose albumin is 1.7 g/dl. The patient's uncorrected calcium is 7.9 mg/dl. You may think this patient's serum calcium is low. Actually, this patient's calcium is within the normal range, once corrected for the low albumin.

$$\mathbf{CA_{corrected} = [(4.0\text{-}1.7g/dl)\ X\ 0.8\ mg/dl] + 7.9\ mg/dl}$$
$$\mathbf{CA_{corrected} = 9.74\ mg/dl}$$

Causes of *Hypercalcemia*	Causes of *Hypocalcemia*
• Malignancy (most common) • Primary hyperparathyroidism (very common) • Excessive administration of calcium salts • Calcium supplements • Prolonged immobility • Paget's disease • Sarcoidosis • Hyperthyroidism • Acute adrenal insufficiency • Lithium-induced renal calcium re-absorption • Excessive vitamin D, vitamin A or thyroid hormone intake • Tamoxifen • Androgenic hormones • Estrogen • Progesterone	• Diminished intake • Medications (calcitonin, EDTA, glucocorticoids, loop diuretics, plicamycin, phosphate salts) • Hyperphosphatemia • Hypoalbuminemia (most common) • Hypomagnesemia • Hypoparathyroidism (common) • Pancreatitis • Renal Failure • Secondary hyperparathyroidism • Vitamin D deficiency (common)

(Fischbach, 1995 & Traub, 1996)

Magnesium (MG)

Normal Range: 1.5-2.2 mEq/L

Magnesium has a diverse role in the body, especially in neuromuscular function and enzymatic action. About 50% of the total body's magnesium is in the bone, 45% in the intracellular fluid and about 5% in the extracellular fluid. Factors that influence calcium also affect magnesium. Magnesium's movement generally follows that of phosphate. For example when phosphate decreases, so does magnesium, and visa versa. Magnesium's movement is generally opposite of calcium.

Causes of Hypermagnesemia	Causes of Hypomagnesemia
• Increased intake in the presence of renal failure • Rapid infusions of IV solutions containing large amounts of potassium • Hepatitis • Addison's disease	• Excessive GI losses • Excessive diuresis • Alcoholism • Poor intestinal absorption (small bowel resection patients) • Diarrhea • Hypoparathyroidism • Hyperthyroidism • Primary aldosteronism • Diabetic ketoacidosis • Pancreatitis

(Fischbach, 1995 & Traub, 1996)

Phosphate (P)

Normal Range: 2.6-4.5 mEq/L

When interpreting lab results, you should look at phoshate and calcium together. Most of the causes of abnormal phosphate levels are the same as that causing abnormal calcium levels. It should also be noted that some labs may also call phosphate "phosphorus". Phosphate is a major intracellular anion. Over four fifths of the body's total phosphate is in the bone. It is important for the intracellular metabolism of proteins, fats and carbohydrates. Phosphate is important in maintenance of the phospholipid cellular membrane and the production of ATP, the chemical compound that provides energy to the cell.. Additionally, phosphate helps regulate the release of oxygen from the hemaglobin molecule, is an important acid-base buffer and plays a role in glycolysis.

Causes of *Hyperphosphatemia*	Causes of *Hypophosphatemia*
• Renal dysfunction (most common) • Decreased renal excretion of phosphate • Shift of phosphate from intracellular to extracellular fluid (occurs during chemotherapy for leukemias and lymphomas, rhabdomylosis, hyperthyroidism and septic shock) • Increased intake of vitamin D or phosphate products	• Decreased dietary intake • Increased renal loss of potassium • Intracellular shifting (administration of concentrated glucose with insulin and when treating hyperkalemia with insulin and dextrose) • Diuretic phase of ATN • Treatment of DKA • Intake of aluminum and calcium containing antacids • Intake of magnesium hydroxide

(Fischbach, 1995 & Traub, 1996)

Carbon Dioxide (CO2)

Normal Range: 22-32 mEq/L

The CO_2 level is related to the respiratory exchange of carbon dioxide in the lungs and is part of our bodies buffering system. Generally when used with the other electrolytes, it is a good indicator of acidosis and alkalinity. The total carbon dioxide level is determined by acidifying serum to convert all of the bicarbonate present to carbon dioxide. Then, the total carbon dioxide content is determined. Since 95% of total serum carbon dioxide is made of converted bicarbonate, this lab test is actually a measure of bicarbonate concentration. The terminology "serum bicarbonate" is used synonymously to describe this value. It is important to understand that this value actually represents bicarbonate, the end product of the carbonic acid/bicarbonate buffer system. It does not measure the acid content in the blood (Fischbach, 1995 & Traub, 1996).

Serum Osmolality

Normal Range: 280-295 mOsm/kg

Serum osmolality is the measure of a pressure caused by solute concentration difference between opposite sides of a semi-permeable membrane. Serum osmolarity which is practically the same as serum osmolalitiy can be derived by:

Serum osmolarity = (2 X Sodium) + Glucose/18 + BUN/2.8

Serum osmolality tells us about the solute concentration in the vasculature. It is increased during times of decreased fluid volume or increased solutes that occur with dehydration or diabetic ketoacidosis. It is decreased in situations such as hypervolemia or true hyponatremia (Traub, 1996).

Glucose

Normal Range: 70-126 mg/dL

The Expert Committee (2003) recognized a group of people whose glucose levels, although not meeting criteria for diabetes, are still too high to be considered normal. This group is defined as having fasting plasma glucose (FPG) levels >100 mg/dl but <126 mg/dl ***or*** 2-hour values in the oral glucose tolerance test (OGTT) of >140 mg/dl but <200 mg/dl. Therefore, the Expert Committee (2003) implemented the following guidelines for fasting blood glucose:

- FPG <100 mg/dl = normal
- FPG =100–125 mg/dl = impaired fasting glucose
- FPG >126 mg/dl = provisional diagnosis of diabetes (the diagnosis must be confirmed by a physician or advanced practice nurse).

Additionally, the Expert Committee (2003) revised its diagnostic criteria for diabetes. It evidence of only one of the following:

- Casual plasma glucose concentration >200 mg/dl + symptoms of diabetes. Casual is defined as any time of day without regard to time since last meal. The classic symptoms of diabetes include polyuria, polydipsia and unexplained weight loss.
- FPG >126 mg/dl. Fasting is defined as no caloric intake for at least 8 h.
- 2-hour post-load glucose >200 mg/dl during an OGTT.

Causes of *Hyperglycemia*	Causes of *Hypoglycemia*
• Diabetes mellitus • Gestational diabetes • Glucose intolerance • Diuretics • Steroids/hormones • Antihypertensives • Phenothiazines • Pyriminil (used in rodent poisons)	• Diabetes mellitus • Pregnancy • Strenuous exercise • Prolonged fasting • Acute alcohol ingestion • Insulin overdose • Beta-blockers • Salicylate overdose • Sulfonylureas

Hemoglobin A_{1C} (Hgb A_{1C})

Normal Range: 4-6%

Hemoglobin A_{1C} or glycosylated hemoglobin measures the quality of glucose control a patient has experience over the previou two to three months. Hgb A_{1C} is based on the premise that a healthy red blood cell lives about 120 days. Glucose is irreversibly bound to the red blood cell. Hgb A_{1C} is used to monitor and adjust therapy in diabetic patients. It is important to bear in mind that A_{1C} levels do not tell the whole story about glucose control. For example, you could have lots of lows and lots of highs and have an excellent "average" blood sugar, and hence an excellent A1C. Labs report the normal non-diabetic range as 4-6%. The recommended goal for HbA1c levels for diabetics is less than 7%. Levels consistently greater than 8% require re-evaluation of the diabetic treatment plan (ADA, 1998 & Diabetes Care, 2005).

Case Studies:

GEORGE T.

George T. is 4 hours post-op hernia repair. As you begin your shift you perform your nursing assessment. You note that he has a BP = 152/92, Pulse = 72, Respirations = 26. Urine output (UOP) in the Foley bag is 800 cc for the past 4 hours. He has full and bounding pulses and increased crackles in his bases. Hanging from the IV pole is an empty bag of D5W. Blood has backed up in George's IV tubing and his IV is clotted off. What is your assessment of this situation?

My assessment is:

_____
_____
_____

JACQELYN M.

Jacquelyn M., a 56-year old patient has been showing signs of mental cloudiness and confusion over the past few weeks. She has a history of breast cancer and was admitted to your unit for severe lower back pain. She also has polyuria and polydipsia, weakness and anorexia, nausea and vomiting. Her reflexes on neurologic exam appear somewhat sluggish. What is the most likely electrolyte abnormality in Jacquelyn?

My assessment is:

_____
_____
_____

MARY F.

Mary is a 21-year-old woman admitted to your unit for an episode of chest pain at home. So far her cardiac work-up is negative. Her major complaints are now vague: she feels "tired" but not sleepy and feels she needs to rest after minimal activity. She lives at the college dormitory. She admits to worrying about her weight and has been dieting recently. She drinks "a fair bit", especially when she is depressed. She does not smoke. No major deviations from normal were noted upon examination. Her lab results are as follows:

Labs

Na	140
K	**2.9**
Bicarb	30
Cl	100
Gluc	87

My assessment is:

_____
_____
_____

SALLY K.

Sally K. is a 32 year-old post-op thyroidectomy patient on your unit. At the beginning of your shift, you note she has the following labs:

Labs

Na	139
K	4.2
Bicarb	29
Cl	99
Glucose	124
CA	**7.0**
P	**5.1**

What is the most likely cause of Sally's hypocalcemia?

My assessment is:

_____
_____
_____

Case Study Responses

GEORGE T

George is hypervolemic. If we checked a serum sodium, it would probably be low right now, due to dilutional effects of fluid overload. A serum osmolality would be high due to the over dilution of solutes in the serum. Additionally, these lab values may be low due to the administration of D5W – which should not be used as a volume expander. Furosemide administration and electrolyte studies are indicated. Be careful when administering electrolytes, because when the excess fluid is removed, electrolytes will most likely return to normal. If you give replacements now, you run the risk of over-correcting their deficits.

JACQELYN M.

Normally, polyuria and polydipsia are signs of increased sodium concentration or increased osmolality. Your concern with this patient is that she may have metastatic brain cancer that is altering the normal function of her pituitary gland – and thus decreasing ADH release. A deficiency in this hormone would cause increased urination and a subsequent increase in thirst for Jacquelyn.

MARY F.

The only abnormality in these labs is a low potassium, which may have contributed to her chest pain. This is a case of a young girl with decreased caloric intake and a subsequent hypokalemia.

SALLY K.
She may have had an accidental removal of her parathyroid glands during her thyroidectomy.

RENAL FUNCTION TESTS

Common values that assess for renal dysfunction include: blood urea nitrogen (BUN), creatinine, BUN/Creatinine Ratios and Creatinine Clearance.

Blood Urea Nitrogen (BUN)

Normal Range: 8-20 mg/dl

BUN is actually the concentration of nitrogen (within urea) within the serum and is a waste product of protein metabolism. It is filtered and reabsorbed along the length of the entire nephron. It is not as reliable at measuring kidney function because it is dependent upon urine flow, renal blood flow, catabolism, protein metabolism, drugs, and diet. BUN better monitors hydration status, protein tolerance, and degree of catabolism. It can also predict the risk of uremic syndrome (when concentrations are greater than 100 mg/dl).

Causes of *BUN Elevation (Azotemia)*	Causes of *BUN depletion*

• **Prerenal causes**
  • Decreased renal perfusion (dehydration, blood loss, shock, CHF)
  • Increased protein breakdown (GI bleed, crush injury, burns, fever, corticosteroid administration, tetracyclines, excessive amino acid or protein intake)
• **Intrarenal causes:**
  • Acute renal failure due to nephrotoxicy, severe hypertension, glomerulonephritis or tubular necrosis)
  • Chronic renal dysfunction as with pyelonephritis, diabetes, glomerulonephritis, renal tubular disease, amyloidosis, arteriosclerosis, polycystic kidney and chronic analgesic overuse)
• **Postrenal causes:**
  • Obstruction of ureter, bladder neck or urethra
  • High protein diet including amino acid ingestion
  • Upper GI bleed (blood is digested as protein)
  • Administration of corticosteroids, tetracyclines, or other drugs with anti-anabolic effects
	• Malnourished
	• Profound liver disease
	• Fluid overload
	• Streptomycin and chloramphenicol may produce falsely low values
	• Blood collection in the incorrect tube(sodium fluoride tube-grey top tube)

Creatinine

Normal Range: 0.7-1.5 mg/dl

Creatinine is a by-product of muscle metabolism. The amount of creatinine produced per day is constant and dependant upon the body's muscle mass. It is freely filtered so that production should equal excretion. Because of this, measuring one's serum creatinine is a very reliable indicator of renal function. As a nurse, you should always suspect renal dysfunction with elevations in serum creatinine, in the absent of changes in the patient's muscle mass.

Causes of *Creatinine Elevation*	Causes of *Creatinine depletion*
• Hemoconcentration (dehydration) • Decreased excretion (Urinary tract obstruction, renal dysfunction) • Increased production (Excess catabolism, excess exercise, hyperpyrexia, hyperthyroidism, muscular dystrophy, myasthenia gravis) • Nephrotoxicity due to drugs (aminoglycosides, amphotericin B, cistplatin, cyclosporine, dextran, gallium, hydroxyurea, lithium, methicillin, methoxyflurane, nitrofurantoin, pentamidine, plicamycin, streptozocin)	• Decreased muscle mass – cachexia • Decreased activity – muscle atrophy • Spinal cord injuries • Patient in a coma or on neuromuscular blocking agents

BUN and Creatinine Ratios

It is important to note looking at your patient's BUN and creatinine together can provide valuable information. For example: BUN and creatinine are elevated inpatients with acute renal failure and suspected dehydration. However the BUN/Creatinine ratio is usually greater than 20:1. Another example is a patient with renal insufficiency experiencing a GI bleed. In this case the BUN/Creatinine ratio is elevated because of low circulating volume and the simultaneous digestion of blood. Typically prerenal causes are responsible for BUN/Creatinine ratios greater than 20:1. Intra renal causes such as nephrotoxicity cause BUN/Creatinine ratios to be between 10:1 and 20:1. Also, ratios greater than 20:1 are not important or reliable if both the BUN and creatinine are within normal limits.

Creatinine Clearance

Normal Range: 90-140 ml/min/1.73 m^2

Creatinine clearance provides great information about your patient's glomerular filtration rate. When looked at in conjunction with other renal function tests, creatinine clearance provides a clear picture about your patient's kidney function in suspected acute or chronic renal failure, allows you to monitor the negative, nephrotoxic effective of some drugs and assists the physician or pharmacist to make adjustments to renally excreted drugs. The relationship between creatinine clearance and serum creatinine is inverse. That is as serum creatinine increases, your patient's creatinine clearance should be decreasing or slowing. It is important to note that creatinine clearance will give you information about your patient's kidney function during early dysfunction. Serum creatinine on the other hand does not begin to rise until your patient has lost about half of their nephrons. BUN is sensitive in early renal failure as well. However, used alone, BUN is not reliable because too many other factors can influence your BUN level. Therefore, when assessing kidney function, especially early on, you should monitor creatinine clearance, BUN and creatinine together.

Your role as a nurse is especially important in obtaining an accurate creatinine clearance value. You may have been asked to obtain a 24-hour urine sample before. When you did so, you had to obtain a special (usually brown) container from your materials management department or central supply. After getting the urine storage unit, you should have labeled it and placed it in the patient's bathroom, on ice. Signs would have been posted indicating that the patient was on a 24-hour urine collection & not to dump any of your patient's urine. Even though the signs were up, the patient was instructed to void only in the urine hat or urinal, and the staff was informed, someone (often yourself) ended up dumping a voided sample into the commode – usually out of habit. Upon informing the physician of this mishap, he or she often appeared very frustrated – maybe even angry. Then, you had the pleasure of starting the process all over again.

It is imperative that ALL of the patient's urine produced in a 24-hour period is collected.

Tips to ensure accurate 24-hour collection:

Instruct the patient to void, then note the time. This is when the 24-hour collection begins. Throw that sample away.

- Collect all voided urine under ice for the next 24 hours.
- Post signs everywhere – especially near the commode.
- Stress the importance of NOT dumping any urine in the commode to the support staff.
- Stress that if it is dumped, to be honest and report it, as it will effect the patient's test results, **and may affect their treatment plan.**
- Encourage the patient if able to remind caregivers not to dump his or her urine when entering the room.

Case Studies

TRICIA W.

Tricia is a 34-year-old female with a 20-year history of type I diabetes. She has a HGB A1C of 7.0% and a blood pressure of 136/84 mmHg. Although her weight has remained stable for years, she has put herself on the latest (high-protein) Atkins diet. Her weight has dropped by 10 lb, her fasting serum triglyceride level has fallen from 175 to 125 mg/dl, and her blood pressure has decreased to 120/72 mmHg. She also has a slower than normal glomerular filtration rate (GFR) of 68 ml/min/1.73 m^2. Please discuss Tricia lab values in context with her history.

My assessment is:

_____
_____
_____

MARY M.

MARY is an 84 year-old woman admitted to your unit with fever and altered mental status. She lives in a nursing home and was found to be unresponsive and febrile this morning prior to her admission to your unit. She has an indwelling Foley catheter and her urinalysis has numerous WBC's and bacteria and was started on gentamycin. What lab values would be important to obtain and monitor closely?

My assessment is:

_____
_____
_____

Case Study Responses

TRICIA W.

Tricia's lab values are consistent with kidney damage. An increasing serum creatinine and a decreasing creatinine clearance. The changes may have been brought on by the high protein diet and her baseline history of type I diabetes – which predisposes Tricia to renal damage.

MARY M.

You should obtain and monitor Mary's serum creatinine and creatinine clearance. Because Mary is elderly, gentamycin (a nephrotoxic drug) may be particularly difficult for her kidneys to handle. Her dose may need to be adjusted.

URINALYSIS

Often we use the results of the urinalysis to give us more clues about the content and consistency of our patient's urine. The urinalysis identifies pathology of the urinary tract and may identify metabolic abnormalities as well. Review the following component of the urinalysis and how abnormal values may be indicative of urinary dysfunction.

COLOR (Normal: Yellow to Amber) - Urochrome gives urine its color. Factors that may alter color include specific gravity, foods, bilirubin, and drugs (pyridium-orange stains that are permanent).

CHARACTER (Normal: Clear) – If urine is cloudy or hazy instead of normally clear, it may be due to white blood cells, bacteria, fecal contamination, prostatic fluid, or vaginal secretions.

SPECIFIC GRAVITY (Normal: 1.015-1.025) is the weight of urine. A low specific gravity indicates dilute urine and a high specific gravity indicates concentrated urine.

pH (Normal: 4.5 –8.0) - Changes seen with acid base imbalances. Values will increase with urinary tract infections and if the specimen is old (ammonia – a base, is produced).

GLUCOSE (Normal: Negative) – The renal threshold for blood sugar is 160-180 mg/dl. Pregnancy, endocrine, and renal problems can lower the renal threshold – thus glucose spills over more easily.

KETONES (Normal: Negative) – Ketones are a product of fat metabolism. Causes of ketonuria include DKA, starvation, fasting, vomiting, strenuous exercise, and dehydration.

PROTEIN (Normal: Negative) – Benign conditions that increase protein in urine are stress, pregnancy, cold, fever, strenuous exercise, and vaginal secretions. Non-benign conditions are hypertension, diabetes (renal damage), post-renal infection (renal damage), and multiple myeloma (also serum protein elevated, A/G ratio abnormal, urine protein up, Bence-Jones proteins up).

BILIRUBIN (Normal: Negative) - Bilirubin in urine is water-soluble – When bilirubin is present in the urine, it is usually due to a hepatobiliary obstruction.

UROBILINOGEN (Normal: Negative to Trace) – When decreased or absent, it may be due to hepatobiliary duct obstruction. When increased, may mean liver damage or hemolytic disease.

BLOOD (Normal: Negative) - If positive, urine is usually cloudy. If dipstick is positive, must look at urine microscopically in the lab for:

(1) Red Blood Cells (RBCs) (urinary tract infection, pyelonephritis, glomerulonephritis, renal cancer, bladder cancer, strenuous exercise, or menses)
(2) Myoglobin (MI, trauma, crush injuries, or burns)
(3) Hemoglobin (transfusion reaction, sickle cell, DIC, or hypertension).

NITRITE (Normal: Negative) – Bacteria is broken down into urinary nitrites and nitrate. Nitrites are positive when bacteria are in urine.

LEUKOCYTE ESTERASE (Normal: Negative) – Reflects presence of white blood cells. Positive findings suggest urinary tract infection.

BACTERIA (Normal: Negative) – If positive, suspect either your patient has a urinary tract infection or the specimen was contaminated.

RBCs (RED BLOOD CELLS) (Normal: Negative) – If >5, think glomerulonephritis, pyelonephritis, renal trauma, tumor, kidney stones, cystitis, or genitourinary malignancy.

WBCS (WHITE BLOOD CELLS) (Normal: Negative) – If > 50, think urinary tract infection. If < 50, it is usually due to exercise, fever, renal disease, or urinary tract disease.

EPITHELIAL CELLS (Normal: Negative) – When present in large to moderate amounts, worry about either acute tubular necrosis or acute glomerulonephritis.

CASTS (Normal: Negative) - When present, may be due to nephrotic syndrome, glomerulonephritis, kidney failure, or renal malignancy.
(Traub, 1996)

Case Studies

CHRIS C.

Chris is a 20 year-old runner with dysuria. Her clean catch urine sample results are listed below. Should we be worried that Chris has a UTI?

U/A PARAMETER	RESULT
Color	Yellow
Character	Hazy
Glucose	Negative
Bilirubin	Negative
Ketones	Negative
Specific Gravity	1.025
Blood	Negative
PH	6.6
Protein	30
Urobilinogen	1.0
Nitrite	Trace
Leukocytes	Negative
WBC	1-5
RBC	Occasional
Bacteria	+1
Collection	Clean Catch

Abnormal values within Chris's U/A are:

Protein *30
Bacteria +1

My assessment is:

_____
_____
_____

ADELE S.

Adele is a 40 year-old female with dysuria. Her clean catch urine sample results are listed below. Should we be worried that Adele has a UTI?

U/A PARAMETER	RESULT
Color	Dark Yellow
Character	Hazy
Glucose	Negative
Bilirubin	Negative
Ketones	Trace
Specific Gravity	1.035
Blood	Trace
PH	7.6
Protein	30
Urobilinogen	1.0
Nitrite	Positive
Leukocytes	Negative
WBC	1-5
RBC	Occasional
Bacteria	+4
Collection	Clean Catch

Abnormal values within Adele's U/A are:

Color – Dark Yellow
Character – Hazy
Ketones – Trace
Specific Gravity 1.035
Blood Trace
Protein *30
Bacteria +1

My assessment is:

_____
_____
_____

Case Study Responses

CHRIS C.

Chris probably does not have a UTI, but rather exercise-related proteinuria.
A history of increased exercise or prolonged physical exertion would be consistent with her U/A findings.

ADELE S.

Adele probably does not have a UTI because the only abnormal value associated with UTIs is the +1 Bacteria. UTIs usually have > +1 Bacteria, Increased pH, Increased leukocyte esterase & possibly increased WBCs. Other values that may be increased with UTIs include casts and blood. A straight catheterization would be helpful in this case.

CONCLUSION

Interpretation of lab values is more than looking to see if a value is inside or outside of the normal range. With today's complex patients, you will find that you need to understand what these values mean, implications of high or low values, and the relationship of different results. Remembering every normal value is probably not as critical as being able to interpret the meanings of the values and how they relate to your patient's clinical condition.

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Your name
Your social security number (required)
Your phone number
The date you took the test
Your RN (or other discipline) license number and state (required for CA nurses)
The complete address where you want the certificate sent

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POST TEST

1. When interpreting abnormal causes of this electrolyte, you should look to determine the cause of abnormal water volume.

   A. Sodium
   B. Potassium
   C. Chloride
   D. Calcium

2. Your patient has been vomiting profusely. All lab electrolytes are normal with the exception of one. Which one is abnormal in the presence of normal sodium and is normally abundant in the stomach?

   A. Potassium
   B. Chloride
   C. Calcium
   D. Magnesium

3. When monitoring this electrolyte, you are very concerned with either high or low values due to its potential to produce life-threatening arrhythmias.

   A. Sodium
   B. Potassium
   C. Chloride
   D. Magnesium

4. You receive an order to administer Calcium Gluconate to your patient whose calcium is low – 8.0 mg/dl. This concerns you because you know that your patient is cachectc and has cirrhosis. You are afraid that his corrected calcium (given his low albumin of 1.5mg/dL) may be normal and by giving him Calcium Gluconate, you could actually make your patient hypercalcemic. What is your patient's corrected calcium and would you give extra Calcium supplement as ordered?

   A. Your patient's corrected calcium is 12.0 mg/dL. You should give supplement.
   B. Your patient's corrected calcium is 10.0 mg/dL. You should give supplement.
   C. Your patient's corrected calcium is 10.0 mg/dL. You should discuss this order with the physician and hold the supplement.
   D. Your patient's corrected calcium is 12.0 mg/dL. You should discuss this order with the physician and hold the supplement.

5. What is the relationship between Magnesium, Phosphate and Calcium?

   A. As Magnesium and Phosphate go up, Calcium goes down.
   B. As Phosphate and Calcium go up, Magnesium comes down.
   C. As Calcium and Magnesium go up, Phosphate comes down.
   D. As Phosphate and Calcium go up, so does Magnesium.

6. The value of CO2 represents what in the body?

   A. Bicarbonate
   B. Acid
   C. Hydrogen ion concentration
   D. Rate of CO2/O2 exchange

7. If your patient has a casual glucose of this value or higher and signs of diabetes, this is diagnostic for diabetes?

   A. 70 mg/dL
   B. 126 mg/dL
   C. 140 mg/dL
   D. 200 mg/dL

8. The HgbA1C measures glucose levels over the previous:

   A. 24 hours.
   B. 7 days.
   C. 30 days.
   D. 60-90 days.

9. The HgbA1C that a diabetic strives for is

   A. Less than 7%
   B. Greater than 9%
   C. 4% or less
   D. 12%

10. One potential problem with the HgbA1C test is that the level can appear at the normal range when there are actually large fluctuations of highs and lows that even out to the normal value.

    A. True
    B. False

11. Which test is the most reliable indicator of renal failure?

    A. Erythropoietin
    B. BUN
    C. Albumin
    D. Creatinine

12. Even though the 24-hour urine collection signs were up, the patient was instructed to void only in the urine hat or urinal, and the staff was informed, you accidentally dumped a voided sample into the commode. What should you do?

    A. Notify physician and start collection over
    B. Don't worry about it, especially your patient isn't producing that much urine anyway
    C. Increase the collection time by 2 more hours.
    D. Try to hide the fact you dumped the urine and continue your collection as if it did not happen..

13. Which lab value is normally negative, but it may be normal to have trace amounts in the urinalysis?

    A. RBC
    B. WBC
    C. Nitrites
    D. Urobilinogen

14. Which lab value may be elevated due to dehydration and extreme exercise in the urinalysis?

    A. RBC
    B. WBC
    C. Nitrites
    D. Protein

15. Which lab value may be elevated in the urinalysis normally during pregnancy?

    A. RBC
    B. pH
    C. Casts
    D. Glucose

16. Your patient has a specific gravity of 1.035. Which of the following is most likely true.

    A. He is hypervolemic
    B. He has Diabetes
    C. He may have CHF
    D. He is dehydrated

Chemistries and Renal Studies

Date Test Taken ____ / ____ / ____ SSN (Required) ____ - ____ - ____

First Name

Last Name

License State Phone

Address

Address (cont.)

City State Zip

	A	B	C	D		A	B	C	D		A	B	C	D		A	B	C	D		A	B	C	D
1.	○	○	○	○	11.	○	○	○	○	21.	○	○	○	○	31.	○	○	○	○	41.	○	○	○	○
2.	○	○	○	○	12.	○	○	○	○	22.	○	○	○	○	32.	○	○	○	○	42.	○	○	○	○
3.	○	○	○	○	13.	○	○	○	○	23.	○	○	○	○	33.	○	○	○	○	43.	○	○	○	○
4.	○	○	○	○	14.	○	○	○	○	24.	○	○	○	○	34.	○	○	○	○	44.	○	○	○	○
5.	○	○	○	○	15.	○	○	○	○	25.	○	○	○	○	35.	○	○	○	○	45.	○	○	○	○
6.	○	○	○	○	16.	○	○	○	○	26.	○	○	○	○	36.	○	○	○	○	46.	○	○	○	○
7.	○	○	○	○	17.	○	○	○	○	27.	○	○	○	○	37.	○	○	○	○	47.	○	○	○	○
8.	○	○	○	○	18.	○	○	○	○	28.	○	○	○	○	38.	○	○	○	○	48.	○	○	○	○
9.	○	○	○	○	19.	○	○	○	○	29.	○	○	○	○	39.	○	○	○	○	49.	○	○	○	○
10.	○	○	○	○	20.	○	○	○	○	30.	○	○	○	○	40.	○	○	○	○	50.	○	○	○	○

1. Were the objectives of the article met?

○ Fully ○ Partially ○ Not met

2. How effective was the content of the article in meeting the objectives?

○ Very effective ○ Effective for the most part ○ Not very effective ○ Not at all effective

3. How effective was the format of the article in meeting the objectives?

○ Very effective ○ Effective for the most part ○ Not very effective ○ Not at all effective

4. How many MINUTES did you spend: Reading the course? Completing the post test?

5. What is one improvement in the course that you would recommend?

6. What other subjects would you like to see added to RN.com?

Comments: