

Urinalysis and Body Fluids CP9

Unit 1 F

Urine Physical Properties

Urine Physical Properties

- Excellent web site on physical properties:
 - http://www.texascollaborative.org/spencer_urinalysis/ds_sub1.htm
- Physical properties
 - simple observations
 - Color and clarity / transparency or turbidity
 - Odor, specific gravity & Volume
 - clues to subsequent findings
 - Example: red & cloudy = possible blood
 - Some abnormal physical properties dictate special or additional tests needed
 - Example: amber color & yellow foam = may need to do Ictotest to verify presence of bilirubin

Urine Physical Property - Volume

- Volume
 - Not usually recorded in routine UA
 - Dependent of body's state of hydration
 - Influenced by fluid intake, loss through non-renal sources (sweat, vomiting, etc.) ADH hormone, etc.
 - Example: diabetics have very large quantities of urine, yet are often dehydrated.
 - Volume required for 'timed specimens' and quantitative tests

Urine Physical Property - Volume

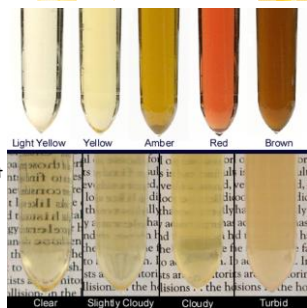
- Volume
 - NV = 600-1600 (ave. @ 1200-1500mL/24 hr)
 - 2-3 times more produced during day than night
- Terms
 - Polyuria - consistent elimination of abnormally large amounts of urine (> 2000 mL/24 hr.)
 - Many possible reasons
 - Diabetes mellitus
 - Diabetes insipidus (suppressed ADH)
 - Diuresis - any increase, even temporary
 - Oliguria - decrease in volume (< 500 mL/24 hr.)
 - Many possible reasons
 - Dehydration
 - Severe burns

Urine Physical Property - Volume

- Terms cont.
 - Anuria - absence of urine formation. Usually due to serious damage to kidneys or the blood flow.
 - Nocturia - excretion of urine at night.
 - Most urine (2-3 x) produced during day.
 - Nocturia may or may not be pathology related.
- QNS - quantity not sufficient for testing.

Urine Physical Properties

- Color & Clarity
 - Varies with concentration, physical activity, ingested substances, & drugs
 - Pathological reasons also affect urine color and transparency



Normal urine color variations

- Color
 - Normal colors: colorless, straw, light yellow, yellow, dark yellow and ~ amber
 - Specimens that are truly amber should be considered suspicious of containing bilirubin / bile



Colorless Straw Yellow Amber/Dark Yellow

Urine Physical Properties - Color

- Cause - pigment byproducts of metabolism
 - Urochrome - yellow pigment (predominant)
 - Normally produced at constant rate, and in normal patients can be good indicator of level of patient hydration.
 - Uroerythrin - red pigment
 - Causes pink-ish color to amorphous crystals (urates) that frequently form in refrigerated specimens.
 - Urobilin - orange-red/brown pigment
 - Oxidation product of urobilinogen

Urine Physical Properties - Color

- Abnormal urine colors
 - May or may not indicate disease
 - May cause problems with readings of dipstick (may need to use 'back up' tests to obtain test results).
 - Most abnormal colors have variety of possible reasons,** Review your textbook.**
 - Amber - possible bile / bilirubin, often associated with hepatitis

Urine Physical Properties - Color

- Pale to colorless - urine often very dilute
- Brown - many possibilities: bile/bilirubin, old blood
- Orange-red - increased urobilin, or possibly medication (pyridium - frequently prescribed for UTI)
- Clear red - hemoglobin (lysed RBCs) or myoglobin (muscle hemoglobin)
- Cloudy red - intact red cells
 - Pinkish red, beets
- Port wine - porphyrins
 - Classic color from a group of related compounds
 - Dipstick for blood is negative
 - Detect with Watson-Schwartz screening test or positive fluorescence under ultraviolet light.
- Cola color - usually old hemoglobin or myoglobin

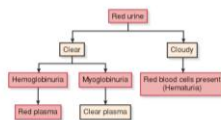
Urine Physical Properties - Color

- Abnormal urine colors Pink, Red, Brown & Black
 - Blood
 - Fresh blood in small amount (acid pH) = pinkish
 - Abundant blood, fresh = red urine
 - Blood in any amount alkaline ph = shade of brown
 - Old blood = shades of brown

Urine Physical Properties - Color

Abnormal colors - Pink, Red, Brown, & Black

- Myoglobin - from breakdown of skeletal muscle tissue
- Low molecular weight - filters easily
- Fresh urine red - brown
- Not found in Patient's plasma



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Urine Physical Properties - Color

- Black -
 - Melanin - oxidation product of colorless melanogen
 - Melanogen released from malignant melanoma.
 - Urine will have normal color when voided.
 - As specimen is exposed to air, melanogen oxidizes to melanin & it turns dark from top down.
 - Homogentisic acid (alkapton bodies)
 - Metabolite of amino acid, phenylalanine,
 - Turns dark as pH becomes alkaline

Urine Physical Properties - Color

- Bizarre urine colors
 - Blues - Greens
 - Can be due to drugs and chemicals
 - Bacteria - Pseudomonas can cause greenish color

Urine Physical Properties

- Urine transparency
 - Also called clarity
 - Clear - normal - fresh urine that is cloudy usually indicates a problem
 - Classifications: clear, slightly hazy, hazy, cloudy, very cloudy, turbid



Urine Physical Properties - Clarity

- Causes - the causes of a non clear urine should be accounted for in the microscopic
 - Amorphous (*no shape*) crystalline material
 - Amorphous urates - acid urine - pink precipitation
 - Amorphous phosphates - alk urine - white precipitation
 - Mucin - or mucous threads
- Pus (*WBCs*) and bacteria
 - Cells - *such as epithelial cells*
 - Other substances - *artifacts; threads from clothing, powder etc.*

Urine Physical Properties - Odor

- Odor - not normally reported out
 - Normal - aromatic
 - Ammonia - from bacterial breakdown of urea
 - specimen is old, allowed to sit at room temp OR
 - patient has a UTI problem
 - Metabolic
 - Sweet (diabetes) / Fruity = ketones
 - Maple syrup = Maple syrup urine disease
 - Musty / Mousy (PKU)
 - Food
 - Onion
 - Garlic
 - Asparagus - need to have the gene to smell it

Urine Physical Properties - Foam

- Foam - not reported out
 - White - possible protein
 - Yellow - may be due to bile / bilirubin



Urine Physical Properties

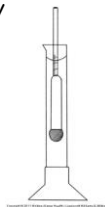
- Specific gravity
 - Definition - Relation of the weight of a solution to the weight of an equal volume of water at a given temperature.
 - Used to measure the concentrating and diluting ability of the kidney.
 - A measure of the density of the dissolved chemicals.
 - Indicates how concentrated the specimen is
 - Increased sp gr = more concentrated
 - Decreased sp gr = dilute urine
 - * Water is used as the point of reference and is assigned the value of 1.000 (sp. gr. is a ratio and has no units)

Physical Properties - Specific Gravity

- Specific gravity measurement
 - Direct methods
 - Urinometer
 - Harmonic oscillation densitometry (HOD)
 - Indirect methods
 - Refractometer
 - Chemical reagent strips

Physical Properties - Specific Gravity

- Urinometer - hydrometer
 - Not very accurate and rarely used.
 - No longer recommended by National Committee for Clinical Laboratory Standards (NCCLS)
 - A calibrated floating device is suspended in a volume of urine.
 - Float displaces the urine
 - (with its greater mass), the level to which the float sinks is measurement of the density of the urine.



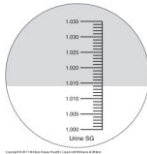
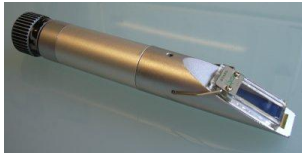
Physical Properties - Specific Gravity

- Refractometer (TS / total solids meter)
 - Most common instrument for measurement of specific gravity.
 - Measures density of solutions by their refractive index
 - Comparing velocity of light passing through air to velocity passing through the solution.
 - More dense the solution the more altered (bent) the light will be.
 - Read result on scale within the TS meter



Specific Gravity - Refractometer

- Refractometer



- This measurement represents a reading of 1.014.

Physical Properties - Specific Gravity

- Refractometer (TS / total solids meter)



Physical Properties - Specific Gravity

- Refractometer (TS / total solids meter)
 - Calculation of specific gravity following a dilution.
 - Reason - occasionally specific gravity too high for reading on scale.
 - Method - make a dilution (usually x2) using distilled/deionized water. Read in TS meter.
 - Example calculation of result:
reading = 1.032
multiply the .032 x dilution factor (usually 2)
report as 1.064

Physical Properties - Specific Gravity

- Osmometer / osmolality
 - Measured either by freezing point or by vapor pressure depression.
 - Measures total solute concentration, but depends on the number of particles in the solution, whereas specific gravity depends on the number and weight of the solutes.
 - Osmolality is a better indicator of the concentrating and diluting abilities of the kidney, because it is unaffected by the density of solutes.

Physical Properties - Specific Gravity

- Osmometer / osmolality
 - Not routinely used in UA screening
 - Usually found in chemistry department where both serum and urine are tested.
 - Measurement is a function of dissolved particles
 - Two basic types
 - Vapor pressure depression (dew point) - measures temperature that water vapor condenses to a liquid
 - Freezing point depression - * most common
 - Normal serum = 275-300 mOsm/kg
 - no set normals for urine, look at ratio between serum and urine, which should be 1:1

Harmonic Oscillation densitometry

- Not commonly used in the clinical laboratory.
- Uses sound waves to measure urine concentration.
- Urine enters a glass tube with an electromagnetic coil at one end.
- Sonic oscillation is generated when an electric current is applied to the coil. The oscillation detected is proportional to the density of the urine.
- A microprocessor corrects sample temperature.
- Result is valid up to a specific gravity of 1.080
- based on change in frequency of sound waves as they are passed through the solution. The waves are altered by the density.

Physical Properties - Specific Gravity



- Urine dipstix with specific gravity - *Most common method used today.
- Measures pK_a change of polyelectrolytes in relation to ionic concentration; actually measures ionic concentration
- Relates to urine specific gravity.
- When more ions are present, more acid groups become disassociated, releasing hydrogen ions and causing the pH to change.
- Indicator then measures the change in pH.
- When urine has an increased specific gravity, the reagent pad becomes more acidic.

Physical Properties - Specific Gravity

- Normal value
 - Overall 1.015 - 1.025 (first morning specimens usually have sp. gr. > 1.020)
- Kidneys are capable of 1.001-1.030 (authors vary; 1.002 - 1.040)
 - Specific gravity > 1.040 by refractometer usually due to X-ray dye Renografin, or Hypaque - these specimens usually also have large amount of sediment from the precipitation of the dye.

Physical Properties - Specific Gravity

- **Related terms**
 - **Isosthenuric:** SG of 1.010 (the SG of the plasma ultrafiltrate)
 - Isosthenuria is a very serious clinical condition where the patient's kidneys are not able to dilute or concentrate the urine. The specific gravity remains fixed at 1.010
 - **Hyposthenuric:** SG lower than 1.010
 - **Hypersthenuric:** SG higher than 1.010

Physical Properties - Specific Gravity

- **Normal random specimens range:**
 - 1.003-1.035; most common 1.015-1.025
 - Below 1.003 may not be urine
 - Consistent low readings: further testing needed

Physical Properties - Specific Gravity

- **Review and Clinical significance**
 - **Osmotic pressure - Specific gravity is a means of assessing kidneys ability to regulate osmotic pressure maintaining homeostasis of body fluids**
 - **Kidney function assess ability of renal tubule cells to regulate concentration**
 - increased fluids should = decreased specific gravity
 - **State of hydration if there is no reason to believe kidneys are malfunctioning, a doctor can use specific gravity to evaluate if patient is properly hydrated.**
 - **Review all the terms related to urine volume.**
