

Urinalysis and Body Fluids CR3

Unit 3
Chemical Examination of Urine

Part3, Ketones

Chemical Exam of Urine - Ketones

- Ketone Bodies
 - Origin
 - Products of fat catabolism
 - Breakdown of fat into CO₂ and water
 - Not normally present in detectable amounts
 - They appear when carbohydrates are not available and the body utilizes fats as an alternative source of energy.



Chemical Exam of Urine - Ketones

- Definitions
 - Ketonuria - *ketones in the urine*
 - Ketonemia - *ketones in the blood*
 - Ketosis - *disease state, when patient has increased amount of ketones.*
 - Acidosis - *state when blood pH is decreased, an accumulation of acids; commonly occurs as a result of ketosis*
 - Ketoacidosis - *blood acidosis as a result of increased levels of ketones.*

Chemical Exam of Urine - Ketones

- Three forms:
 - Acetone
 - constitutes 2%.
 - Acetone is volatile, & excreted primarily through the lungs
 - Diacetic Acid (Acetoacetic)
 - the first formed
 - both acetone and beta hydroxybutyric acid are produced from diacetic acid.
 - Diacetic acid is the form detected by most ketone test procedures. Makes up 20 % of total.
 - Beta hydroxybutyric Acid
 - majority formed
 - although most of the ketones are this form, it is not detected by routine test.
 - Only Hart's test, an old 'wet chemical' test that is designed to detect B-hydroxybutyric acid

Chemical Exam of Urine - Ketones

- Clinical Significance
 - Health - formed in liver and completely metabolized
 - Disease - excessive formation and accumulation
 - Disturbance of carbohydrate metabolism
 - when there is a decrease of carbohydrate metabolism, then the body stores of fat must be metabolized to supply energy.
 - As a result of this increased fat metabolism ketones will be found in the urine.
 - Low carbohydrate diets (Atkins types)
 - Diabetics not in control

Chemical Exam of Urine - Ketones

- Other conditions
 - Persons exposed to cold / severe exercise
 - Febrile conditions
 - High fat diets / ketogenic diets
 - Starvation / malnutrition
 - Vomiting and diarrhea, esp in children
 - Van Gierke's Disease - glycogen storage disease
 - Inborn error in carbohydrate metabolism, results in limited availability of carbohydrates.
 - Pyloric stenosis (sometimes in babies)
 - Affected infants have prolonged loss of gastric contents
 - resulting in starvation ~ ketones.
 - But also a frequent loss of the HCl from the stomach means loss of HCl - results in overall alkalosis instead.
 - So - while ketosis is most often associated with acidosis, when caused by pyloric stenosis - can result in overall alkalosis.

Chemical Exam of Urine - Ketones

- Physiological Effect
 - - 2 of the 3 ketones are metabolic acids.
 - Can you name them?

Chemical Exam of Urine - Ketones

- Physiological Effect
 - pH of the blood lowered
 - normally the blood pH is 7.40,
 - but the presence of increased keto-acids lowers both blood and urine pH . (condition is called ketoacidosis)
 - Excessive acid excreted in urine (lowers urine pH)
 - Urine ketones can be found before significant levels can be seen in the blood, increasing the importance of urine screening, especially in emergency situations.
 - Toxicity - brain damage by
 - acetoacetic / diacetic acid
 - and acetone

Screening / checking for Ketonuria

- Diabetic Ketonuria
 - diabetes mellitus
 - out of control diabetic will have ketones in their blood and urine.
 - Checking for ketones in urine - Provides clue to early diagnosis of ketoacidosis and diabetic coma
 - Pregnant diabetic - fetal death due to ketoacidosis
- Others
 - monitor a patient who is trying to change from insulin to an oral hypoglycemic agent
 - Ketonuria shows poor response
 - Also, oral agents lose effectiveness if the patient has a current infection.
 - Ketones in the urine would demonstrate that the patient's oral hypoglycemic medication is not working

Chemical Exam of Urine - Ketones

- Typical urine *of the diabetic patient*
 - Low pH - *from keto acids*
 - High specific gravity - *the presence of increase glucose*
 - High glucose - *positive test*
 - Pale and maybe somewhat greenish color
 - Ketones - *positive test*
- *(what would you look for in the microscopic?)*

Chemical Exam of Urine - Ketones

- Ketone Tests
 - most use nitroprusside
 - which detects diacetic acid and a small amount of acetone,
 - but does *not* detect β -hydroxybutyric acid.

Chemical Exam of Urine - Ketones

- **Acetest** - tablet
- Reagents
 - Sodium nitroprusside
 - Aminoacetic acid (glycine)
 - Disodium phosphate - provides optimal pH
 - Lactose
- Chemistry
 - Reacts with AA and acetone to give purple color
 - Very sensitive (10 mgs/dL in urine)
 - *Most sensitive to diacetic acid / acetoacetic acid (10 X)*
 - *Also can detect acetone (1 X)*
 - *Not at all sensitive to beta hydroxybutyric acid*
 - Can be used for **urine, serum, EDTA plasma, or whole blood.**



Chemical Exam of Urine - Ketones

- **Urine dipsticks**
 - Reagents - same as Acetest (primarily sodium nitroprusside)
 - Chemistry - similar to Acetest
 - Used for serum or urine



Urine ketone: false positive or atypical color

- Highly pigmented urines
- Combination of high specific gravity and a low pH
- Levodopa metabolites
- Sulfhydryl groups
- Phenylketones
- Phthalein compounds
- Positive and questionable results may be confirmed with a tablet test.

Urine ketone: false negative

- Controls solutions that use acetone.
- ****Old specimens**
- ****Specimens that have been heated.**
- General precaution: always test fresh specimens.

Reference Listing

- Please credit those whose work and pictures I have used throughout these presentations.
- Lillian Mundt & Kristy Shanahan, Graff's Textbook of Urinalysis and Body Fluids, 2nd Ed.
- Susan Strassinger & Marjorie Di Lorenzo, Urinalysis and Body Fluids, 5th Ed.
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