

Urinalysis and Body Fluids CS

Unit 3

Chemical Examination of Urine Part 2 - Carbohydrates

Session Outline

- Overview of glucose formation and metabolism
- Other carbohydrates
- Diabetes mellitus and other carbohydrate metabolism issues
- Testing procedures
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Chemical Exam of Urine - Glucose and Other Urine Sugars

- **Glucose**
 - Normally contained in glomerular ultrafiltrate
 - Reabsorbed in the proximal tubule
 - Usually not present unless threshold levels exceeded
 - Normal concentration of glucose in blood
 - *Fasting - 70-110 mg/dl*
 - *After meal - 120-160 mg/dl - returns to normal fasting within @ 2 hours*
 - *Glucose renal* threshold: 160-180 mg/dl
 - **Glucosuria** - glucose in the urine

Chemical Exam of Urine - Glucose and Other Urine Sugars

- **Glucose & carbohydrate metabolism**
 - Monosaccharides
 - Glucose
 - Fructose
 - Galactose
 - Simple sugar structures
 - end products of carbohydrates digestion
 - Fructose and galactose are converted by the liver to glucose
 - Using various pathways cells utilize glucose as their main source of energy.

Chemical Exam of Urine - Glucose and Other Urine Sugars

- **Glucose & carbohydrate metabolism**
 - Carbohydrates absorbed at duodenum and small intestine (primary way of obtaining carbohydrates for energy)
 - Excess glucose is stored in liver and muscle tissues in the form of **glycogen**.
 - Greater excesses are stored as adipose tissues.

Chemical Exam of Urine - Glucose and Other Urine Sugars

How the body gets glucose.	Defined / characteristics
Absorption in duodenum	Primary way body gets glucose
Glycogenesis / gluconeogenesis	The conversion of non-carbohydrate precursor substances into glucose. 2 nd way the body obtains glucose
Glycogenolysis	The hydrolysis or breakdown of the stored glycogen turning it back into glucose. This occurs primarily in the liver and is the 3 rd way to obtain glucose.

Chemical Exam of Urine - Glucose and Other Urine Sugars

- **Hyperglycemia**
 - increased glucose in the blood
- **Glucosuria (glycosuria)**
 - glucose in the urine
 - **Dependent upon**
 - Blood glucose levels
 - Glomerular filtration rate
 - Tubular reabsorption
- **Diabetes mellitus - most common condition resulting in hyperglycemia and glucosuria**

Diabetes mellitus

- Most common condition resulting in hyperglycemia
- Cause - deficiency or abnormal function of hormone insulin produced by the Beta cells in the Islets of Langerhans of the pancreas. Insulin is necessary for glucose to enter the cells.
- **Result**
 - Increased blood glucose
 - Increased urine glucose
 - Positive glucose,
 - Increased specific gravity
 - Increased loss of water through urine (polyuria)
 - Increased thirst (polydipsia); increased hunger (polyphagia)
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Diabetes mellitus

- **Detection - urinary glucose and blood sugar screenings**
- Health surveys
- Periodic medical examinations
- patients with recurring infections
- special groups
 - relatives of diabetics
 - Obese
 - patients over forty
 - women who have babies over 9 lbs or stillbirths
- **Management depends on type and severity - diet, or injected insulin *also oral medications.***

Chemical Exam of Urine - Glucose and Other Urine Sugars

- "Diabetes of Pregnancy"
 - (*latent diabetes*)
 - Some women develop glucosuria during the 3rd trimester of pregnancy.
 - It may be due to a change in metabolism of insulin or a glucose intolerance.
 - Controlled by diet.

Chemical Exam of Urine - Glucose and Other Urine Sugars

- **Diabetes insipidus** - review.
 - Not a glucose disorder,
 - but because of its name, can be confused with diabetes mellitus.
 - Caused by a decreased production or function of *the hormone ADH antidiuretic hormone also called* (Vasopressin).
 - Decreased ADH = decreased permeability of membranes, decreased reabsorption of water, increased volumes of urine with low specific gravity.

Comparison: diabetes mellitus and diabetes insipidus

☼	mellitus	insipidus
hormone	insulin	ADH
urine volume	<i>increased</i>	<i>greatly increased</i>
urine specific gravity	<i>increased due to glucose</i>	<i>decreased</i>

Chemical Exam of Urine - Glucose and Other Urine Sugars

- Other potential causes of urine glucose
 - Alimentary
 - *eat too much glucose*
 - Primary familial renal glucosuria
 - *persons with low threshold*
 - Pregnancy - *discussed*
 - Disorders involving renal tubules
 - *decreased ability to reabsorb*
 - Destructive pancreatic disease
 - Endocrine disturbance - *other than pancreas,*
 - *pituitary gland, thyroid, & adrenal gland hormones*
 - Damage of central nervous system
 - Excitement and stress - *mobilize glucose*
 - Infections

Chemical Exam of Urine - Glucose and Other Urine Sugars

- Define reducing substances - and explain how they can affect certain glucose testing methods.
- Reducing substances in urine
 - substances that can reduce Cu^{2+} to Cu^{+} (*copper II to copper I*) in a chemical reaction.
 - These substances can affect / cause a + reaction of the Clinitest.

Chemical Exam of Urine - Glucose and Other Urine Sugars

- Sugars other than glucose
 - Are normally converted to glucose by the liver.
 - Rarely appear in the urine
 - _____uria.
 - many of them are reducing substances.

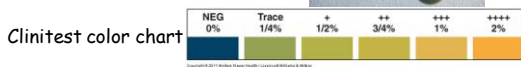
Chemical Exam of Urine - Glucose and Other Urine Sugars

Sugar	Reducing substance	Characteristics
Glucose	Yes	Increased levels in blood and urine in diabetics
Fructose	Yes	Fruit & honey sugar. Rare inherited met. Disorder
Galactose	Yes	MOST important non-glucose sugar. Comes from lactose. Deficient enzyme: galactose - 1 phosphate uridyl transferase. Must screen young children to prevent brain damage due to Galactosemia.
Lactose	Yes	Milk sugar. Seen in women - late pregnancy and during lactation. Also in premies
Pentose	Yes	Certain fruits, such as cherries, plums. Rare met. disorder
Maltose	Yes	2 glucose molecules tied together. Reducing sugar, but not found in urine.
Sucrose	NO	Common table sugar. 1 glucose + 1 fructose molecule. Bound together ins such a way as cannot reduce. Also not found in urine.

Chemical Exam of Urine - Glucose and Other Urine Sugars

Reducing substances other than sugars
Drugs
Salicylates - aspirin
Chloral hydrate
Camphor & Paraldehyde
Increased levels of creatinine
Increased levels of uric acid
Increased levels of ascorbic acid (vitamin C) *
Dextrins
Homogentisic acid (remember alcaptonuria?)
Glucuronates

Clinitest



Clinitest - Copper Reduction Test

- Semi-quantitative test
- Principle - Copper reduction; Cu II is reduced to Cu I in the presence of heat and alkali
 - $2 \text{Cu}^{++} + \text{Reducing Sugar} \rightarrow \text{Cu}_2\text{O} + \text{Oxidized Sugar}$
- Clinitest Reagent tablet
 - Copper sulfate (*provides the Cu II*)
 - citric acid,
 - sodium hydroxide (*provides the heat*)
 - sodium carbonate.
- Detects *all* reducing substances; NOT specific for glucose.
- PURPOSE: Used on infants and children to detect galactosuria.

Chemical Exam - Clinitest

10 drops DI water

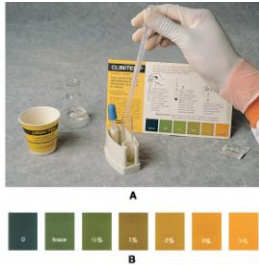
___ drops urine

Mix. Add tablet (carefully)

Observe reaction, match to

appropriate color chart

WARNING: reaction tube becomes very HOT.



Chemical Exam - Clinitest

- Be sure to observe for: "Pass-through phenomenon"
 - At high glucose levels, the color produced passes quickly through the orange stage and returns again to blue before the end of the specified time. This problem can be avoided by using a 2 drop method instead of the usual 5.
- Interferences by other reducing substances
 - Ascorbic acid, (which causes false + on Clinitest, will suppress the glucose, blood, bilirubin, nitrite and leukocyte esterase dipstick reactions)

- certain antibiotics (cephalosporin),
- Drugs

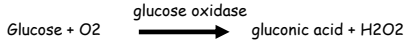


Urine glucose

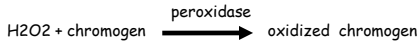
Glucose color chart



Reaction A:



Reaction B:



Chemical Exam of Urine - Glucose

- Advantages
 - Sensitivity - very sensitive.
 - *low level of 50-100 mg (compared to Clinitest's 250 mg) 50-* Can have a positive dipstick but a neg Clinitest
- Specificity - is specific for glucose only.
 - *not affected by other sugars or reducing substances.*

Chemical Exam of Urine - Glucose

Urine Dipstick Glucose Reaction Interferences	
False Positives	Oxidizing cleaning agents / detergents Peroxide Hypochlorite (bleach) Increased urobilinogen with some automated methods
False Negatives OR Decreased Sensitivity	Cool / cold specimens Increased specific gravity Alkaline pH Increased ketones High dose ascorbic acid (mega-dose vitamin C) **Testing old samples

Chemical Exam of Urine

Correlation of Clinitest and enzyme tests

DIPSTICK	CLINITEST	Significance
positive	negative	glucose present in small amount
negative	positive	non-glucose reducing substance
positive	positive	glucose present
negative	negative	no glucose; no other reducing substances present in measurable amount

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.
- > Wikipedia, the free encyclopedia
 > www.wikibedia.org

Chemical Exam of Urine

