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Vitreous Postmortem Chemical Analysis

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The autopsy, a medical procedure and gold standard for cause of death determination as well as quality of care assessment and improvement, is more than just gross dissection and microscopic analysis. In this modern era, ancillary studies such as microbiology, toxicology, electron microscopy, immunology, molecular techniques such as DNA analysis, and clinical chemistry tests including hemoglobin electrophoresis, high-performance liquid chromatography, and metabolic screening are routinely used during postmortem investigations. Over the years, the use and addition of these ancillary laboratory studies has greatly enhanced the utility of the autopsy.

An important and frequently utilized ancillary study is postmortem vitreous chemical analysis. Many diseases have specific associated abnormal chemistry values including electrolyte imbalances, ketone production, and abnormal glucose levels. Unfortunately, after death, the blood is a poor choice for such analyses due to the rapid breakdown of cell membranes and autolysis that occurs in serum. Because of this fact, chemistry abnormalities that were present in patients before death are often more accurately reflected after death in vitreous fluid instead of blood. This increased accuracy makes vitreous fluid the specimen of choice for many chemical analyses after death.

At autopsy, approximately 1 mL of vitreous fluid can be procured from each eye by inserting a needle into the globe at the lateral canthus. This does not preclude open casket viewing of the body. Vitreous is viscous, colorless, and clear; and it is composed mainly of water (>90%), glucose, inorganic salts, hyaluronic acid, type II collagen fibers, and ascorbic acid. It is acellular and relatively isolated, rendering it less susceptible than blood to biochemical changes, bacterial degradation, and contamination.

In order to interpret postmortem vitreous chemistry, one must first understand the normal findings in the vitreous. (see Table 1) After death, cell membranes become permeable. Potassium immediately begins to diffuse from inside retinal cells out into the vitreous resulting in potassium levels that increase over time. For this reason, vitreous potassium has been used to estimate time of death and postmortem interval. Sodium, chloride, creatinine, and urea nitrogen are more stable than potassium, and reflect premortem levels for up to 120 hours after death. Therefore, increased and/or decreased levels of these analytes in postmortem analysis may be indicative of and useful for diagnosing many diseases. (see Table 2) Variables such as environmental temperature, decedent's

age, and postmortem interval can affect the components of the vitreous and must be taken into consideration.

The vitreous can also be analyzed for glucose, ketones, alcohols, and certain drugs. A glucose level of <200 mg/dL is considered normal. Because glucose levels decline rapidly after death, a postmortem vitreous glucose level of >200 mg/dL is diagnostic of diabetes. Ketones may be detected in cases of diabetic ketoacidosis (DKA), malnutrition/starvation, alcoholic ketoacidosis, and isopropanol ingestion. Certain laboratories report ketones as a category whereas others will differentiate beta hydroxybutyrate, acetoacetate, and acetone. Beta hydroxybutyrate is the major ketone produced in DKA and alcoholic ketoacidosis. Acetone is the major ketone produced in cases of malnutrition/starvation and isopropanol ingestion. However, it must be remembered that even when isopropanol is not ingested, low levels may be present due to conversion of acetone to isopropanol in one of these ketogenic states. Ethanol can be detected in the vitreous fluid approximately two hours after ingestion; vitreous ethanol levels lag behind blood levels by approximately two hours. After death, ethanol may be produced through the decomposition process resulting in an elevated blood ethanol level up to 100 mg/dL. However, ethanol is not generated to an appreciable level in the vitreous compartment because it is a relatively isolated site in the body. It is difficult to extrapolate backwards and attempt to determine the amount of alcohol ingested or the timeframe, and such calculations are discouraged. Other drugs, such as cocaine, morphine, heroin, and tricyclic antidepressants may also be detected in the vitreous. The significance of their levels varies and can be compared to previously documented toxicology data.

Table 1. Normal Values of Postmortem Vitreous Chemical Analysis

Normal	**Na mmol/L**	**Cl mmol/L**	**K mmol/L**	**Cr mg/dL**	**VUN* mg/dL**	**Glucose mg/dL**	**Ketoacids + or -**	**R-OH* mg/dL**
Vitreous	135-150	105-135	<15	0.6-1.3	8-20	<200	Neg	Neg

* VUN = vitreous urea nitrogen, R-OH = alcohol

Table 2. Postmortem Vitreous Chemical Analysis in Some Common Diseases

Condition	**Na mmol/L**	**Cl mmol/L**	**K mmol/L**	**Cr mg/dL**	**VUN mg/dL**	**Glucose mg/dL**	**Ketoacids + or -**	**R-OH mg/dL**
Hypernatremic dehydration	>155	>135		↑	>40			
Isonatremic dehydration				↑	↑			
Hyponatremic dehydration	<135	<105		May be ↑	↑			
Renal failure				↑	↑			

Azotemia, uremia				↑	>150			
Low salt pattern	<135	<105	<15					
Decomposition	<130	<105	>20					+
Vomiting		<105						
Diabetes						>200		
Diabetic ketoacidosis						>200	+	
Nonketotic hyperosmolar coma	May be ↓			May be ↑	May be ↑	>200		
Water intoxication	<135	<105	<15					
Malnutrition/ Starvation							+	
Ethanol ingestion								+
Acute ethanol toxicity binge	<135	<105	<15					>350 mg/dL
Isopropanol ingestion							+	Isopropanol
Alcoholic ketoacidosis						<200	+	

Suggested Readings

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