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THE CLINICAL VALUE OF THE PLASMA ACETONE TEST
FRED W. WHITEHOUSE, M.D.*

Diabetic ketoacidosis is always a medical emergency. In the best institutions, the mortality is still five to ten percent. Early diagnosis and vigorous treatment with insulin and fluid are mandatory to the restoration of metabolic balance. Accurate assessment of the degree of ketosis will aid the clinician in judging the severity of the individual case and in planning adequate replacement therapy.

The determination of the degree of ketonemia is the best method of estimation of the severity of ketosis. While the quantitative method is accurate, it is also time-consuming, and speed is important in the early hours of the management of ketoacidosis. Duncan1,2 has emphasized the value of the qualitative determination of ketonemia in the diagnosis and management of diabetic ketoacidosis. A more widespread familiarity with this simple test is warranted.

TECHNIC

Two milliliters of either plasma or serum is obtained from the patient at the time of the initial venipuncture. The sodium nitroprusside test for ketone bodies is used, employing either Acetest tablets (Ames Co.) or Acetone test powder (Denver Chemical Co.). Both of these commercially available preparations are quite satisfactory. A series of four test tubes is set up for serial dilution of the plasma or serum with water or normal saline, using respectively, (1) undiluted plasma, (2) one drop of plasma in one drop of diluent, (3) one drop of plasma in three drops of diluent, and (4) one drop of plasma in seven drops of diluent. Then, one drop from each tube is placed upon the reagent and the intensity of color change is recorded in thirty to sixty seconds. This is compared with the standard color chart. The reaction is graded negative to 4 plus.

Under normal conditions, there is no demonstrable ketonemia by this test. The reagent in question is specific for ketone bodies, and no false positives or false negatives have been recorded. While diabetes mellitus is the outstanding condition causing ketosis, starvation, malnutrition and other states associated with increased fat metabolism result in ketosis. The distinguishing feature between the latter and diabetic ketoacidosis is the degree of ketonemia, being many-fold greater in the patient with diabetic ketoacidosis.

With adequate renal function, rapid clearance of ketone bodies from the plasma will occur, giving rise to marked ketonuria without significant ketonemia. This may occur early in the development of ketoacidosis. The currently available “powder” tests for acetone are extremely sensitive and will detect minute amounts of acetone in the urine. Hence, only the determination of plasma acetone will accurately supply the information essential for the proper assessment of the degree of ketosis. Figure 1 illustrates the physiologic progression of acetonuria and acetonemia in diabetic ketosis.

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PLASMA AND URINARY ACETONE
IN DIABETIC KETOSIS

(QUALITATIVE NITROPRUSSIDE TEST)

ACETONE
IN URINE

ACETONE
IN PLASMA

Normal — 0 ————0

DEVELOPMENT
OF
SEVERE
KETOSIS

Figure 1

Plasma and Urinary Acetone in Diabetic Ketosis (Qualitative nitroprusside test). A reproduction of Figure 2 in Duncan, G. G., and Gill, R. J.: Clinical value of a simple qualitative test for plasma acetone in diabetic coma, Diabetes 2:353, 1953.

The following case reports exemplify the value of the plasma acetone test in diagnosis and management.

Case 1. M.W., a 32 year old white female with known diabetes of twelve years' duration was seen in the emergency room with a history of nausea and vomiting of two days' duration. There was minimal dehydration, and the vital signs were normal except for hyperpnea. The blood sugar was 380 milligrams percent and the CO₂ combining power was 11 milliequivalents. The urinalysis showed 4 plus glycosuria and acetonuria. The plasma acetone test was 2 to 3 plus in the undiluted specimen. Treatment with 90 units of crystalline insulin and 3000 milliliters of intravenous fluid resulted in restoration of metabolic balance. Eight hours later, the blood sugar was 165 milligrams percent and the CO₂ combining power was 20 milliequivalents.

Comment: While the alkali reserve was moderately depressed, the clinical state and the degree of acetonemia supported early ketoacidosis. Relative insulin sensitivity remained, and a small amount of supplementary insulin and fluid corrected the metabolic derangement. The degree of alkali deficit is valueless in assessing the gravity of the metabolic derangement in diabetic ketoacidosis.

Case 2. F.McG., a 35 year old colored male was seen in the emergency room with the classical signs and symptoms of diabetic ketoacidosis. A blood sugar was 550 milligrams percent. The CO₂ combining power was 4.5 milliequivalents. Glycosuria and acetonuria were 4 plus. The plasma acetone test was 4 plus in the undiluted
specimen and in the first tube dilution. Treatment included 500 units of crystalline insulin and 6000 milliliters of intravenous fluid over an eighteen-hour period. There was a satisfactory recovery from the ketoacidosis.

Comment: Severe ketoacidosis with insulin resistance was accurately assessed early by the knowledge of the degree of ketonemia. Vigorous therapy corrected the metabolic abnormalities promptly.

Case 3. R.M., a 33 year old white female was admitted to the in-patient department with the complaint of shortness of breath and drowsiness. The patient had known diabetes for sixteen years. Glycosuria on admission was 4 plus, and acetonuria was 2 plus. The blood sugar was 500 milligrams percent, and the CO₂ combining power was 2.9 milliequivalents. The plasma acetone test was negative to trace. Later, a non-protein nitrogen was 188 milligrams percent. The diagnosis was renal acidosis secondary to diabetic nephropathy. Insulin sensitivity remained. Treatment consisted of fluid replacement with sixth-molar lactate solution and small amounts of crystalline insulin over a twelve-hour period. Adequate control of the hyperglycemia was obtained with 75 units of crystalline insulin. Death occurred three days later of uremia.

Comment: The patient was admitted semi-comatose with Kussmaul respirations and standard laboratory findings consistent with the diagnosis of diabetic ketoacidosis. The absence of significant ketonemia pointed to the correct diagnosis of renal acidosis. Treatment included smaller amounts of insulin and intravenous fluid than would apply to a patient with a similar degree of ketoacidosis. This case emphasizes the real value of the plasma acetone test in the differential diagnosis of acidosis occurring in the patient with diabetes.

Case 4. D.O., a 39 year old colored female, a new patient to the hospital, was admitted on the Obstetrical service because of persistent nausea and vomiting and drowsiness. She was in the thirtieth week of her sixth pregnancy. She had known diabetes of nine months’ duration and was following no medical program. On physical examination, there was a tachycardia and a mild hyperpnea. The tongue was moist and the eyeballs firm. Her admission urinalysis showed 4 plus glycosuria and acetonuria. Her plasma acetone test was negative. Later, a blood sugar was 231 milligrams percent and a CO₂ combining power was 14 milliequivalents. Eight hours after 44 units of crystalline insulin and 2000 milliliters of intravenous dextrose and water, she was improved clinically, and the glycosuria was 1 plus and the acetonuria was negative.

Comment: Diabetic ketoacidosis did not exist. Rapid evaluation of the metabolic derangement with the aid of the plasma acetone test permitted prompt institution of corrective therapy. In the pregnant diabetic, early restoration of metabolic balance will help prevent intrauterine fetal death. The pregnant diabetic is vulnerable to ketosis and acidosis.

DISCUSSION

The use of the plasma acetone test is of great value in the proper assessment of the acutely ill diabetic patient. In the patient with glycosuria and clinical signs of diabetic ketosis, the finding of significant acetonemia establishes the diagnosis of diabetic ketoacidosis. No other clinical condition gives this combination of clinical and
laboratory findings. The application of the serial dilution technic to this test permits rough quantitations of the degree of acetonemia and accurate estimation of the severity of ketoacidosis. The latter parallels the degree of ketonemia. Renal acidosis in the diabetic patient may simulate ketoacidosis, but can be easily distinguished by the plasma acetone test. Starvation, pregnancy and uncontrolled diabetes may give rise to heavy ketonuria, but can be quickly distinguished from significant ketosis by the use of this test. The difficult differential diagnosis of diabetic ketoacidosis and acute salicylate intoxication has recently been emphasized. The use of the plasma acetone test may have further value by aiding the clinician when this situation arises. Serial plasma acetone determinations may be used in following the progress of the patient with diabetic ketoacidosis. The degree of ketonemia will progressively fall as sufficient insulin is supplied to reconstitute carbohydrate metabolism.

SUMMARY
The plasma acetone test is a simple, rapid and accurate method of determining the degree of ketonemia and the severity of ketosis. It is invaluable for the early diagnosis of diabetic ketoacidosis, and in the differentiation of other conditions simulating ketoacidosis. Familiarity with this test will aid the clinician in the proper assessment of the acutely ill diabetic patient.

BIBLIOGRAPHY