Treatment of Diabetic Coma

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The basic principles in the treatment of diabetic coma are divided into two main parts. Immediate emergency treatment includes measures to restore carbohydrate metabolism to normal; to overcome dehydration; to eliminate ketosis; in extreme cases only, to combat acidosis specifically; and to treat precipitating factors, such as acute appendicitis, acute pyelitis and pyelonephritis. Management in the convalescent period demands watchfulness (for relapse and hidden infections), continued treatment of precipitating factors, and rapid nutritional rehabilitation with special reference to protein deficits and vitamin deficits.

FACTORS AFFECTING MORTALITY

The mortality rates from diabetic ketotic acidotic coma as reported in various large medical centers vary from one to 40 per cent depending on the age of the patient, the duration and intensity of the ketotic acidosis, precipitating and complicating diseases and the adequacy of the therapeutic procedures.

Delay in diagnosis and in the initiation of adequate treatment leads to many unnecessary fatalities. During the routine instruction of patients in their general care, they should be taught to recognize an impending decompensation of the diabetes and to treat the earliest stages rather than waiting for ketosis to develop.

Patients are instructed to test their urine for sugar every 4 hours during an episode of fever, vomiting, diarrhea, or very marked anorexia. They are further instructed to administer supplementary doses of regular insulin in accordance with prearranged scale. This prophylactic measure, it is felt, has saved many a patient from emergency hospitalization for ketotic acidosis. The supplementary insulin, over and above the daily scheduled dose, suppresses the glycosuria and polyuria, and thus prevents dehydration and loss of minerals; it enhances carbohydrate metabolism, thus preventing excessive ketone formation and accumulation. Very few well-instructed patients who cooperate ever develop an intense ketotic acidosis.

ADEQUATE THERAPY

It was stated in the introduction that the mortality rate depended upon the adequacy of the therapy. What is adequate therapy and how is it achieved?

From the metabolic point of view the first essential step is to restore carbohydrate metabolism. This in turn will stop the catabolic destruction of protein, allow orderly and normal fat metabolism, reduce the rate of ketone body formation, and allow for the metabolism of the already existing excess of ketones. For this purpose, the essential therapeutic agent is insulin, meaning the water soluble regular insulin or the solution of insulin crystals with its comparatively short period of latent activity, its rapid availability and high intensity activity. The next question is: How much and how often?

DOSAGE OF INSULIN

The amount of insulin required must be individualized. It is the amount required to produce the therapeutic effect desired. This may vary from 100 to 5000 units in the first 24 hours. Insulin must be given with full appreciation of the urgent necessity of restoring carbohydrate metabolism as rapidly as possible without endangering the patient with severe hypoglycemia. This goal can be achieved by following certain "rules of thumb" and the use of educated guessing, or as the psychologists say, "the integration of the unconscious associative processes with past experience."

The three factors that help determine the initial insulin dosage are: the age of the patient, the severity of the acidosis, and its duration. As a rule, older people should receive less insulin initially than younger patients. An average starting dose of insulin for patients over 45 years of age who manifest intensive glycosuria and ketonuria is 50 units an hour. With the younger

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patients, it is more common to give from 75 to 100 units an hour for the initial dosage. However, since the amount of insulin administered is to some extent dependent upon the type of fluid administered, this subject will be reopened further along.

ACIDOSIS, DEHYDRATION, AND SALT DEPLETION

The hyperglycemia and resultant glycosuria initiate a chain of events that result in the clinical picture of acidosis. The diuresis provoked by the glycosuria drains tremendous amounts of salts from the body. The hyperglycemia increases the effective osmotic pressure of the blood and consequently draws water from the cells which in turn became dehydrated. This water drawn from the cells dilutes the extracellular components with resultant apparent decrease in concentration of the blood sodium and chloride. At the same time there is an increase in the concentration of the circulating potassium. Since we know that the diuresis causes a marked loss of potassium from the body, and the draining of the intracellular fluid to the extracellular spaces dilutes the circulating solutes, then the observed increase in potassium concentration is a manifestation of a tremendous discharge of potassium from the cells to the extracellular fluid. This release of potassium from the cells is probably related to the interference with carbohydrate metabolism. With the return of adequate carbohydrate metabolism under the influence of insulin, there is a decreasing concentration in the serum which will be discussed later.

In addition to the salt loss, the diuretic effect of the glycosuria produces dehydration. These changes are responsible for the circulatory disturbances which are the immediate threat to the patient's life. This discussion is not intended to minimize the acidosis per se which results from the ketosis. However, so much discussion in the past has been given to this aspect of the subject that it will be handled very briefly. In the intermediary metabolism of fat the 4 carbon chain acids are produced. Normally these are oxidized at a rate sufficient to prevent their accumulation. In the absence of adequate carbohydrate metabolism the rate of production of these 4 chain ketotic acids is increased. Since their rate of oxidation is not materially increased there is an accumulation in the circulating blood. Base is required to neutralize them and they are excreted as the sodium and ammonium salts to a large extent. This loss of base from the body results in the decreased alkaline reserve or acidosis. This brief discussion on the mechanism of the production of the dehydration syndrome is given as a background for the discussion of the choice of fluid to be used for intravenous therapy to combat this major immediate threat to the patient.

PARENTERAL FLUID THERAPY

The most widely discussed point in this respect is whether or not glucose should be administered intravenously in the treatment of diabetic coma.

The pros argue that hyperglycemia facilitates the combustion of glucose. The small increase in glucose combustion obtained this way can be obtained by increasing the insulin dosages. Insulin is still the most effective stimulation of glucose metabolism.

The cons argue that hyperglycemia provokes glycosuria with its attendant dehydration and the administration of glucose defeats its own purpose. Both schools of thought are correct. The solution to this perplexing therapeutic problem is not too difficult if one does not take an arbitrary extreme point of view.

Immediately after the initial dosage of insulin, it is my practice to give normal saline intravenously. This solution is continued until evidence is obtained that the administered insulin is exerting its action on the concentration of sugar in the blood and urine; the insulin being administered in hourly doses of 50 to 100 units. If, after four hours, there is no evidence of decreasing hyperglycemia and glycosuria or ketonemia and ketonuria then the hourly insulin dosage is increased. Those patients who will fall into the category of the insulin resistant can be detected within the first four hours and their lives saved by aggressive insulin administration above usual requirements, and further investigation for complications. If glucose is administered immediately, it masks the earliest insulin activity as well as provoking increased diuresis. Once the evidence of insulin activity is available, then glucose may be added to the intraveous solution. The actual time interval between the first injection of insulin and the doses of intravenous glucose may be from one to six hours. In the initial plan of treatment, the exogenous source of glucose is not needed as the glycemic levels are usually well above 400 mg. in each 100 c.c. The imperative action is first to replace salt and water.

LABORATORY TESTS

Many guides have been suggested to use in determining the initial amount of insulin administered. Blood sugar levels, when and if available, are good. However, the holiday and week-end routine of many hospitals precludes its use. On week days, at best, an hour or more is

required to obtain an analytical result. This delay is dangerous to the patient. The analysis of the urine for ketones and glycosuria is much simpler and quicker.

Many physicians use an indwelling catheter. They believe the information obtained saves more lives than the occasional resulting pyelitis destroys. It is better to have a live patient with pyelitis than a dead one with a sterile urinary tract. Others will not catheterize their patients but depend on clinical judgement, plus analysis of blood when available. That is a personal choice, but all sources of information available should be used. In unconscious patients, it is absolutely necessary to catheterize. Furthermore, it provides a measure of renal function by watching hour to hour urinary secretion.

The recent popularization of the standard Rothera test for bedside determinations of blood ketones has much in its favor, particularly in determining initial doses of insulin. The higher the concentration of blood ketones determined by a simple dilution test the greater the initial amounts of insulin required.

POTASSIUM THERAPY

Another controversial point in the treatment of diabetic coma is the use of intravenous potassium. As stated previously, in untreated diabetic coma there is usually an increase in the serum potassium. When the administered insulin reaches its peak activity there is usually a decrease in serum potassium occasionally resulting in symptoms of potassium deficiency. Certainly, for the first four to seven hours of treatment it is dangerous to give potassium intravenously. If the patient is able to take any fluids or food by mouth, the intravenous administration is definitely not indicated as all fruit juice, boullion and most foods contain adequate amounts of potassium. After that, if real evidence of potassium deficiency exists, as shown by the flame photometer or electrocardiograph, then it is permissible to give it. When potassium chloride is given intravenously 30 m. equiv. or about 2.2 gm. per litre of saline or glucose is safe. Another contraindication is impaired renal function.

Alkalis are seldom administered intravenously. There are occasional patients whose loss of alkali reserve has been so great that they will benefit from this form of replacement therapy.

NUTRITION DURING CONVALESCENCE

To speed the convalescence of these patients it must be borne in mind that they have been through a severe catabolic episode. They have suffered extensive destruction of body protein and loss of vitamins with resultant interference with the enzyme systems. The prescribed diet should be more than the previous maintenance diet in the precoma period. Provision must be made for the nutritional rehabilitation and restoration of the protein reserves. Extra protein, in the presence of adequate calories, with supplementary vitamins in adequate dosage must be prescribed for a period of several weeks.

VOLUME OF FLUID

The question of the total amount of fluid to be administered is one of clinical judgement based upon the presenting signs. In face of circulatory collapse transfusions of whole blood are indicated.

The total amount of saline and saline plus glucose may vary from 4 to 20 litres. Fluids must be given until the specific gravity of the urine is restored to normal levels and tissue hydration is obtained. These amounts of fluid presuppose good renal functions and adequate circulatory status.

CONCLUSION

Basic principles in the treatment of diabetic coma are the immediate emergency measures and the management during convalescence. In the emergency measures, regular insulin is the therapeutic agent of choice. It must be given in adequate amounts with the full appreciation of the urgent necessity of restoring carbohydrate metabolism as rapidly as possible. Fluids must be given intravenously in true ketotic acidotic coma as soon as insulin treatment is started. The initial solution is physiologic saline solution.

The crucial time in the treatment schedule of the true coma patient occurs at about the 4th to the 7th hour. If there is no decrease in hyperglycemia or glycosuria, insulin administration must be pushed more aggressively as one must suspect unusual insulin requirements. If glycosuria and hyperglycemia start to decrease, then glucose may be added to the intravenous solution. If the flame photometer is available, serum potassium determinations, at this point, should be done and potassium salts administered only if definite indications exist.

The physician is reminded that true ketotic acidotic coma is a catabolic episode and that the patient loses excessive quantities of protein nitrogen from the body; therefore, in the diet prescription following such episodes, adequate provision must be made for the replenishment of the nutrients lost, such as protein, riboflavin, and other vitamins.