EMERGENCIES IN GENERAL PRACTICE**DIABETIC AND INSULIN COMA**

BY

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The treatment of severe diabetes mellitus involves the use of one or more of the many insulin preparations now available and the prescription of a suitable diet. There is an increasing tendency for the routine management of these patients to be undertaken in special hospital out-patient clinics, partly because in some cases it is difficult and time-consuming, and partly because the help of dietitians and other ancillary workers may be required. The general practitioner is apt to see his diabetic patients only if some emergency arises, such as an intercurrent infection or the development of ketosis or severe hypoglycaemia. When this happens, lack of familiarity with the patient's diabetic condition makes his task much harder.

Diabetic Coma and Pre-coma

It is now generally accepted that diabetics fall broadly into two groups—those who are underweight and those who are overweight when the condition is recognized. It seems likely that in the first type insulin-lack is the underlying cause, whereas in the second type insulin is still being produced by the pancreas in approximately normal amounts. Both groups have a high blood sugar with glycosuria and polyuria, but those suffering from insulin lack tend, in addition, to produce an excess of ketone bodies unless adequate replacement therapy is given. If these ketone bodies are being formed so fast that they accumulate in the blood, the patient may be said to be in a state of diabetic ketosis, and unless treatment is given will deteriorate, first becoming drowsy and finally unconscious. Coma resulting from severe diabetic ketosis is fortunately rarely seen nowadays, and the practitioner is concerned with recognizing the condition in the pre-coma stage, which in itself is to be regarded as a medical emergency.

Severe diabetic ketosis or diabetic pre-coma is usually defined on a biochemical basis (carbon dioxide combining power less than 20 vols.%), but on clinical assessment it may be said to be present when, following a period of severe diabetic imbalance, there is evidence of dehydration and the patient's breath smells strongly of acetone. In this condition there is a heavy glycosuria and in almost all cases ketone bodies are present in sufficient concentration to give a positive ferric chloride reaction.

Patients with recently developed diabetes rarely reach the stage of severe ketosis before seeking medical advice. Known diabetics may go into ketosis because the dose of insulin prescribed for them is inadequate or because their syringe is defective and they are not getting the full amount. Much more commonly it follows a sudden increase of insulin requirement produced by an intercurrent infection, usually of the upper respiratory or gastro-intestinal tract. Occasionally an emotional upset increases the insulin requirement enough to lead to diabetic ketosis.

Recognition of Severe Diabetic Ketosis

Severe diabetic ketosis does not develop in a matter of hours: with very few exceptions the patient will give a history of thirst, polyuria, and nocturia for several days. As the ketosis becomes more severe, appetite is lost and increasing nausea is followed in many cases by vomiting. Intense thirst persists until consciousness is lost. Some patients, when they lose their appetite or start to vomit,

reduce or omit their insulin injections—a step that still further aggravates their condition. Constipation is the rule and is occasionally associated with severe abdominal pain suggestive of an acute attack of appendicitis or some other surgical emergency. In a few cases the acidotic respiration is very striking and the patient's chief complaint is of breathlessness or dyspnoea.

A history of increasing thirst and polyuria followed by nausea and vomiting in a diabetic patient should warn the practitioner of the possibility of diabetic ketosis. The most important findings on physical examination are signs of dehydration—a dry red tongue, inelastic skin, and often a reduction of blood pressure. The breathing is usually very deep and may be rapid. The breath smells strongly of acetone.

Examination of the urine is of great importance, and, unless the patient is unconscious or severe dehydration and hypotension have led to impairment of renal function, there is seldom any difficulty in obtaining a specimen. This should first be tested for sugar. There is no longer any need to use Benedict's solution or to boil the urine in a test-tube over a spirit flame. The "clinitest" tablet method has been shown to be accurate and reliable and is much more convenient for use in the patient's home. If the urine contains less than 2% sugar it is extremely unlikely that the patient is in diabetic ketosis. An approximate quantitative assessment of the percentage of sugar in the urine is obtained from the colour chart provided with the tablets. Corresponding colours obtained with Benedict's test, using 0.5 ml. urine and 5 ml. reagent, are as follows:

		Clinitest Colour		Benedict Colour
0%	..	Blue	..	Blue
1%	..	Yellow-green	..	Cloudy green
1%	..	Yellow-brown	..	Yellow
2% or more	..	Orange	..	Red

If there is a heavy glycosuria the urine should next be tested for ketones: a number of methods are available. The sodium nitroprusside or Rothera test is extremely sensitive and in practically all cases of severe diabetic ketosis it is very strongly positive. The ferric chloride test is much less sensitive and a true positive result indicates a gross ketonuria and the presence of a severe degree of ketosis. Unfortunately, however, salicylate medication leads to a false-positive reaction in the ferric chloride test and it is not uncommon for patients, feeling unwell on account of their unbalanced diabetes, to take a couple of aspirins. Methods are available for distinguishing the false-positive from the true-positive ferric chloride reaction, but these involve boiling the urine for 10 minutes and are not really suitable for use in the patient's home. Recently a tablet modification of the Rothera test has been introduced and has greatly simplified the detection of significant degrees of ketonuria. When using the "acetest" tablet a ++ or +++ reaction indicates marked ketonuria, corresponding to a true-positive ferric chloride reaction. It must be emphasized that the colour given by the acetest tablet is much weaker than that of the original Rothera test, and any patient giving a ++ or +++ result on the chart provided with the tablets should be considered to have severe diabetic ketosis and to be in urgent need of treatment.

Diagnostic Difficulties

A number of conditions have been incorrectly diagnosed as diabetic ketosis: salicylate poisoning, meningococcal meningitis, and subarachnoid haemorrhage may be quoted

as examples. Such errors are rare and may be avoided by careful consideration of the clinical features and critical assessment of the results of the urine tests. There are two situations, however, which more often give rise to difficulty.

Obese diabetics, seriously ill with cerebral or coronary thrombosis, often develop some degree of starvation ketosis. The presence of ketonuria in a drowsy or comatose diabetic may lead to the diagnosis of diabetic ketosis being made. Obese diabetics, however, do not lack insulin and are not liable to develop true diabetic ketosis. The differentiation between true diabetic ketosis and starvation ketosis occurring in a seriously ill obese diabetic is of some prognostic importance. Diabetic ketosis usually responds dramatically to suitable treatment, whereas large doses of insulin are unlikely to help the obese diabetic.

Severe diabetic ketosis may on very rare occasions be present without ketonuria. Failure to excrete the ketones is the result of secondary impairment of renal function. These patients always have oliguria. The clinical features and especially the strong smell of acetone in the breath should point to the correct diagnosis.

Prevention of Diabetic Ketosis

The practitioner is particularly concerned with the prevention of ketosis in a diabetic patient who develops an intercurrent infection. Not only must he treat the infection as intensively as possible but also ensure strict control of the diabetes. These patients should be instructed to test their urine before each meal, or, if they are not taking food, at least four times a day. If the intercurrent illness is severe, long-acting insulins (globin, protamine zinc, or insulin zinc suspension) should be discontinued and regular doses of soluble insulin given instead. One-third of the previous total dose should be given six-hourly; when calculating the dose to be taken the practitioner should ask to see both the insulin bottle and the syringe and verify the usual dose taken. This is necessary because patients often refer to marks on the syringe as units, and as most syringes are graduated for single-strength insulin, whereas that usually used is double or quadruple strength, confusion can easily arise.

If the urine tests continue to show 2% or more of sugar the insulin dose should be increased by about 10% every six hours until the urine sugar falls to 0.5% or less. When the urine is sugar-free, the insulin dose should be reduced. If the patient is unable to take food, glucose drinks should be given at a rate of about 10 g. of glucose hourly (10 g. glucose=approximately one level tablespoonful of glucose powder). If there is severe vomiting insulin should still be given based on the results of the urine tests, but if the urine sugar falls below 2% while there is a heavy ketonuria (++) or (+++) with acetate tablets) parenteral therapy is indicated and the patient should, if possible, be sent into hospital. If the intercurrent infection is only mild the patient's usual insulin may be continued, but if there is 2% of sugar in the early morning urine the dose should be increased by 10% (patients using protamine zinc insulin alone or insulin zinc suspension should increase the dose by 20%) and further tests taken before each meal. If 2% glycosuria continues an additional small dose of soluble insulin should be given before meals and at bedtime.

The method of control outlined for these patients is only applicable if the renal threshold for glucose is normal. Some diabetics have an abnormally low threshold and pass sugar in the urine, sometimes up to 2%, while their blood sugar is in the normal range. Patients soon discover if they have this abnormality, and know that for them a sugar-free urine is a warning of impending hypoglycaemia. In these cases the best indication that an increase of insulin dose is needed is the presence of thirst and polyuria, but, if the intercurrent infection is at all severe, blood-sugar estimations are likely to be needed and admission to hospital should be advised.

Emergency Treatment of Severe Diabetic Ketosis

Severe diabetic ketosis requires hospital treatment, and this is essential if there is dehydration associated with nausea or vomiting. Furthermore, experience has shown that a delay of even a few hours may influence the ultimate outcome, therefore the practitioner should initiate treatment before leaving the patient's home. Every practitioner should have a supply of soluble insulin (80 units per ml. strength) and of sterile ampoules of 50% glucose solution, so that he can take them on any emergency call to a diabetic patient. In severe diabetic ketosis soluble insulin in large doses is required, and if the practitioner is certain of the diagnosis he should give 50 to 100 units by deep intramuscular injection. A dose of 100 units is to be regarded as the standard for a case of severe ketosis with dehydration, nausea, and vomiting, but if the patient is a previously undiagnosed diabetic or a child the dose should not exceed 50 units.

In less severe cases without any nausea or vomiting, treatment can, when necessary, be undertaken at home. If the patient is an adult and a known diabetic, treatment should be started with a dose of 50 units of soluble insulin. At the same time fruit-flavoured saline drinks should be ordered (2.7 g. of salt—about half of a level teaspoonful of table salt—in a pint (570 ml.) of water) and given at the rate of one to two pints (half to one litre) every three hours. After the first three hours glucose should be added to the drinks, about 50 g. spread over each three-hour period. Urine tests should be made every three hours and the insulin dose repeated if the urine still contains more than 2% sugar. If the patient is unable to produce a urine specimen after three hours, it suggests that the blood sugar has been reduced to the normal range and that in consequence the glycosuria and polyuria are controlled; the next insulin dose should therefore be omitted. As the glycosuria decreases, glucose and insulin in smaller doses should be continued until the ketonuria is abolished. If the patient is responding satisfactorily to treatment a reduction of the ketonuria should be apparent by the sixth hour; if this has not been achieved or if there has been vomiting at any time in the course of treatment it is probably advisable to send the patient into hospital. The principal steps to be taken in the management of patients with diabetic ketosis treated at home are given in the following table:

Treatment of Diabetic Ketosis at Home

Note: This is not suitable for patients who are nauseated or vomiting.

On making the diagnosis give 50 units of soluble insulin intramuscularly and start fruit-flavoured saline drinks.

At 3 hours:

Obtain a urine specimen and test for sugar and ketones.

If urine sugar 2% give 50 units of insulin

" " " 1% " 32 " " "

" " " 0.5% " 16 " " "

" " " sugar-free or if no specimen obtainable omit insulin

Add glucose to saline drinks—50 g. every three hours

At 6 hours:

Obtain and test urine specimen

Repeat insulin as at three hours

Continue glucose-saline drinks. If glycosuria is 0.5% or less, milk and light diet may be started

If there has been no improvement in the patient's condition and ketonuria, transfer to hospital is advisable

If the ketosis has been precipitated by an intercurrent infection immediate steps should be taken to treat the infection.

Hypoglycaemic or Insulin Coma

Although "insulin reactions" or mild hypoglycaemic attacks are quite common in diabetics taking insulin, severe episodes leading to coma are relatively rare. The commonest causes of insulin reactions are unusual exercise, missed and delayed meals, or a sudden alteration in the insulin requirement. The reactions resulting from physical exertion may be somewhat misleading in patients taking long-acting insulins, because, instead of occurring during or immediately after the

exercise, they tend to be delayed and to come on during the night or even the next day. Reactions due to a sudden alteration of insulin requirement may occur after an illness in which the insulin dose has had to be increased. When the patient is convalescent and resumes normal activity the insulin requirement often falls rapidly and it is difficult to judge the dose required.

Recognition of Hypoglycaemic Coma

Patients on soluble insulin usually have adequate warning that their blood sugar is falling dangerously low. Blurring of vision, slurring of speech, unsteadiness of gait, sweating, or a sense of unreality all draw attention to the need for glucose or other easily assimilated carbohydrate food. Patients using long-acting insulins may have insulin reactions following this pattern, but in some cases there may be loss of consciousness without any of the warning signs; in others the patient becomes disorientated and violent so that he fails to appreciate the situation and may refuse to take a glucose drink. Another danger with the hypoglycaemic attacks of the long-acting insulins is that they tend to come on during the night. When this happens a severe attack will result in the patient being found to be unrouseable in the morning. Mild nocturnal hypoglycaemia often leads to unpleasant nightmares, and the patient wakes the next morning drowsy, and with a headache which may be relieved by breakfast or persist through the day.

When the blood sugar falls to an unusually low level during a hypoglycaemic attack, typical epileptic convulsions may occur. In older patients with cerebral vascular disease Jacksonian fits and hemiplegia may result from mild hypoglycaemia.

Hypoglycaemic coma compared to diabetic coma is a condition of rapid onset. The patient is seen going about his business and apparently quite well, and then half an hour later he is found unconscious; or he goes to bed normal in the evening and the next morning he cannot be roused. Further details about the case are of value in making the correct diagnosis. It is helpful to know that the patient is a diabetic taking insulin—for this reason all diabetics who take insulin should carry a card giving the details. Secondly, a knowledge of the patient's meals and activities may give a clue to the diagnosis, whether at the time the attack came on the patient was late for a meal or whether there had been some unusual physical exertion.

On examination there is usually a striking absence of physical signs. The patient, unless actually having an epileptic convulsion, appears to be sleeping quietly, breathing normally, well hydrated but pale, and sometimes sweating. In severe attacks the plantar responses may be extensor and in older patients there may be signs of a hemiplegia. Urine examination is of little value; the presence of urine in the bladder containing 2% sugar does not exclude hypoglycaemic coma, because the urine may have been secreted before the blood sugar fell, or the patient may have a low renal threshold. In some cases a trace of acetone may also be present.

Emergency Treatment of Hypoglycaemic Coma

Hypoglycaemia is a dangerous condition. If the nutrition of the brain is seriously affected, recovery may be delayed or never occur; after a severe episode of hypoglycaemia the patient may be dull and retarded for several months, and permanent mental defect has been described in children after repeated attacks. Immediate treatment is needed, and the best way to restore the blood sugar in an unconscious patient is to give an intravenous injection of 40 ml. of 50% glucose solution. In most cases the patient will rouse after this has been given, but after a severe attack it may be 24 hours or more before consciousness is regained. If the patient fails to respond to intravenous glucose, arrangements should be made for transfer to hospital so that continuous intravenous therapy can be given. If the patient does respond, glucose drinks should be given by mouth; this is particularly important if the attack is due to a long-acting insulin, because

the patient can easily slip back into hypoglycaemic coma. A dose of 50 g. of glucose should be given at once in about 300 ml. of fruit juice, followed by a further 50 g. an hour later, or, better still, if the patient is able to take it, a normal meal.

Some of the most severe attacks have occurred when a patient found in coma due to hypoglycaemia has been incorrectly diagnosed as being in diabetic coma and given a large dose of soluble insulin. The differentiation between these two types of coma is seldom difficult—hypoglycaemia comes on rapidly or overnight, the patient is not dehydrated, and there is no smell of acetone in the breath. Coma due to diabetic ketosis follows several days of severe thirst and polyuria, and the patient is drowsy for 12 hours or more before consciousness is lost, dehydration is marked, and the breath smells strongly of acetone. If the practitioner is in any doubt, an injection of 50% glucose solution should be given; this will lead to an immediate improvement in nearly all cases of hypoglycaemia, whereas if the case is really one of diabetic coma little or no harm will result.

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ADVANCES IN CARDIOVASCULAR SURGERY

REPORT OF AN INTERNATIONAL SYMPOSIUM AT THE HENRY FORD HOSPITAL, DETROIT, MARCH 17-19

[FROM A SPECIAL CORRESPONDENT]

The outstanding contribution to this symposium was that of WALTON LILLEHEI (Minneapolis). Earlier in the programme a panel had discussed the diagnosis and treatment of congenital pulmonary stenosis, during which WILLIS POTTS (Chicago) and HELEN TAUSSIG (Baltimore) described their vast experience with the indirect or shunt operations and Sir RUSSELL BROCK (London) strongly advocated direct surgery in the form of either pulmonary valvotomy or infundibular resection; the latter even went so far as to state that in the future the treatment of the tetralogy of Fallot would be a direct operation during which each of the congenital malformations would be corrected. It was Lillehei who showed that such an operation is now a reality. He reported the results of 30 operations on patients using a controlled cross-circulation technique which allows the surgeon to open the heart widely and gives plenty of time for carefully performed intracardiac procedures under direct vision.

Septal Defects

Lillehei had confirmed the work of Andraeson that both venae cavae can be clamped for 20 to 30 minutes provided the azygos venous flow continues, which means that no great quantity of blood need be provided by an external circulation to maintain life. In his technique the donor's (usually the mother) superficial femoral artery is cannulated and the blood passed through a small pump to the patient's aorta via the subclavian artery, the flow being reinforced when necessary from a reservoir of oxygenated blood collected from the arteries of other donors. The blood is