ABC of Diabetes

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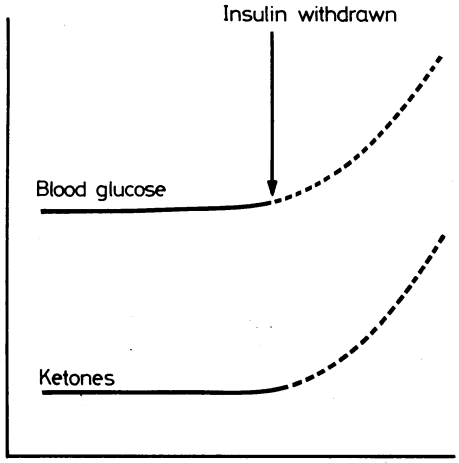
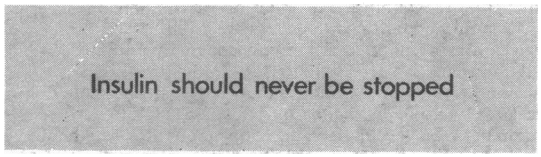
DIABETIC EMERGENCIES

Ketoacidosis



Ketoacidosis results from a lack of insulin. In practice it is usually due to:
(*a*) stopping insulin or reducing the dose—in error or deliberately;
(*b*) resistance to insulin during infections;
(*c*) the unrecognised onset of insulin-dependent diabetes.
The clinical onset of ketoacidosis occurs over hours or days. Symptoms of uncontrolled diabetes are always present. Vomiting in an insulin-dependent diabetic is always serious. Patients usually consult their doctors during the preceding days, but the presence of uncontrolled diabetes is nearly always overlooked. Diabetic control should always be assessed if a diabetic becomes unwell for any reason. Almost all cases of ketoacidosis can be prevented.

Preventing ketoacidosis



KING'S COLLEGE HOSPITAL—DIABETIC DEPARTMENT

ILLNESS AND INFECTION

During illness or infection your blood sugar level may rise, causing you to feel dry, thirsty and pass too much urine. Urine tests may become sugary (2%) every time.

You **MUST** continue to take your normal insulin dose. **NEVER** stop it. You may need an increased dose if your urine tests are bad. If you are vomiting, consult your Doctor or the Diabetic Clinic at once. If you are unable to eat, take your carbohydrate portions in liquid form—e.g. milk, Lucozade, Ribena.

Test your urine twice a day or even more frequently.

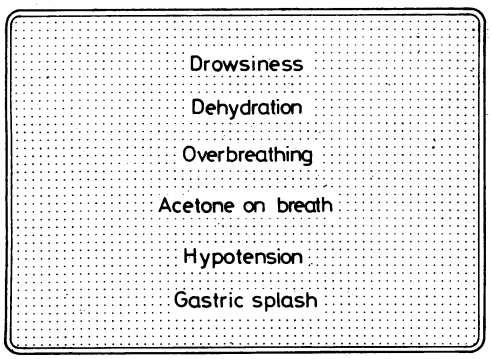
If you continue to feel unwell, consult your Doctor.

During any illness or infection the blood glucose concentration tends to increase and diabetic control deteriorates. Most diabetics then need a larger dose of insulin than usual, and some who normally take tablets may need insulin just during the illness. The increased need for insulin occurs even when appetite declines or vomiting begins.

It is helpful to give every insulin-dependent diabetic a small printed card with the simple instruction "Insulin should never be stopped." Stopping or even reducing insulin during the course of an illness often leads to diabetic ketoacidosis.

When a diabetic is ill the normal insulin dose should be continued, carbohydrate taken in some palatable fluid form, and the urine tested regularly—four times a day if necessary. When appropriate, blood glucose should also be tested. If heavy glycosuria (2%) persists the dose of short-acting (soluble) insulin should be increased. Additional doses of soluble insulin (about 8 units) may also be given at noon or bedtime when control is very poor. If vomiting continues without remission for more than a few hours admission to hospital for treatment with intravenous fluids and insulin is advisable to prevent ketoacidosis.

Recognising ketoacidosis



Dehydration is the most obvious clinical feature of patients with ketoacidosis. They are also drowsy, but rarely unconscious—"diabetic coma" is an inappropriate description; overbreathing, but not usually breathless; their breath smells of acetone (though many people cannot smell this); and many also have a gastric splash. More severe cases are hypothermic and hypotensive. Aketotic cases are similar but without overbreathing or the smell of acetone.

Diagnosis

- Blood glucose
- Serum potassium and sodium
- Acid-base status
- Urea creatinine
- Plasma ketones (Ketostix)
- Blood count
- Blood culture (when indicated)

The diagnosis of ketoacidosis is confirmed by laboratory tests.

Urine test shows heavy glycosuria and ketonuria.

Blood glucose concentrations may range from slightly increased to extreme hyperglycaemia. The blood glucose concentration itself does not usually indicate the severity of the illness.

Blood acid-base state—pH ranges from normal to 6·9. The bicarbonate value is depressed.

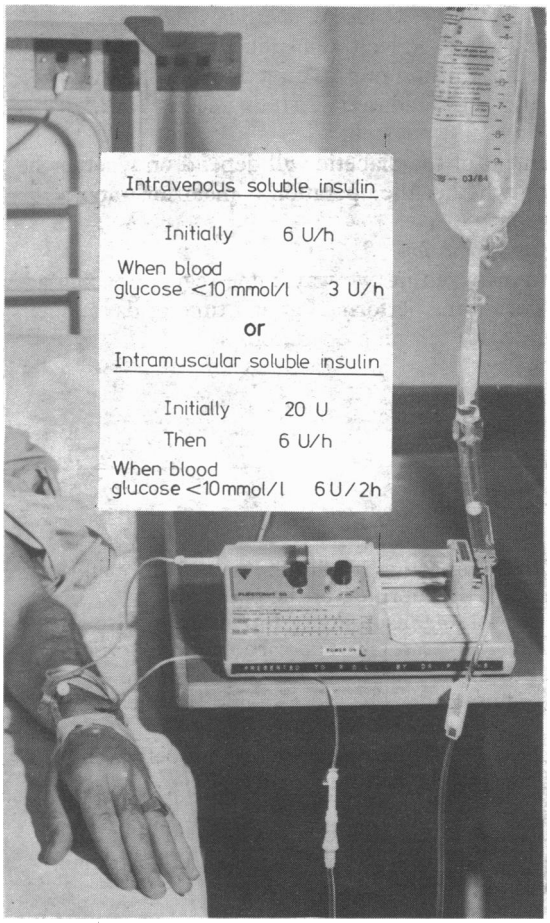
Plasma ketones are easily detectable with Ketostix. In patients with ketoacidosis the results on plasma Ketostix testing should be ++ or +++. The plasma Ketostix test is useful if acidosis is thought to be due to another cause, such as lactic acidosis.

Electrolytes—The serum potassium concentration is usually but not always raised. This measurement is vital, and lifesaving treatment is needed to maintain potassium values in the normal range. The sodium concentration is normal or reduced and urea and creatinine concentrations are often raised through dehydration.

Blood count—If a blood count is performed the white count is often spuriously raised to 15-20 $\times 10^9$/l even in the absence of infection.

Treatment

Normal saline:	1 l in first half-hour	0–½ h
	1 l over next hour	½–1½ h
	1 l over next hour	1½–2½ h
	1 l over next 2 hours	2½–4½ h
	1 l over next 3 hours	4½–7½ h
	1 l over next 4 hours	7½–11½ h
Total:	6 l	over 11½ hours



(1) Insert a nasogastric tube (unless the patient is fully conscious). Do not allow any fluids by mouth; if patients are thirsty they may suck ice.

(2) Give intravenous fluids. The regimen needs to be modified according to age, weight, and the presence of cardiac disease. In seriously ill patients or those with cardiac disease a catheter for measuring central venous pressure is useful. A suitable regimen for most patients is shown. Saline 0·9% is used.

The fluid should be changed to dextrose-saline once the blood glucose concentration has fallen to less than 10 mmol/l. The rate of infusion is determined by individual need but at this stage should probably be about 1 litre every 8 hours.

(3) Start intravenous or intramuscular soluble insulin immediately.

Insulin treatment

Intravenous insulin—Soluble insulin is diluted in 0·9% saline in a syringe, at a concentration of 1 unit/ml. It is given by infusion pump (or paediatric drip set) at 6 units/h (0·1 unit/kg/h for children) until the blood glucose concentration is less than 10 mmol/l. Blood glucose should fall at a rate of about 5 mmol/l/h. Then the dose may be reduced to 3 units/h. Higher infusion rates are rarely needed; when they are needed, in insulin-resistant cases, the rate should be doubled or quadrupled, etc. The insulin infusion is continued until the patient is well enough to eat. Preprandial subcutaneous soluble insulin is then given and intravenous insulin discontinued after the meal. Intravenous insulin should not be stopped before subcutaneous insulin has been given.

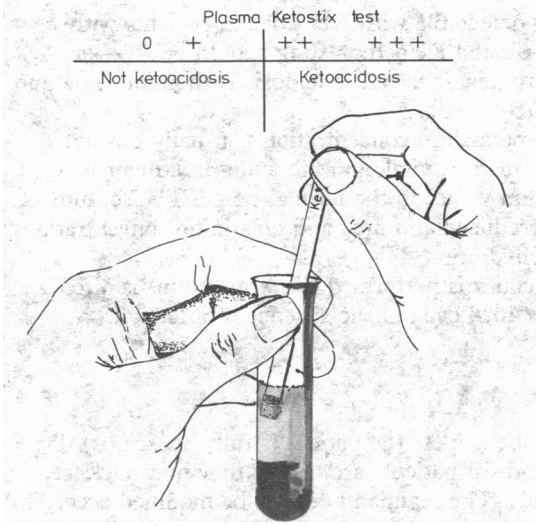
Intramuscular insulin—Soluble insulin 20 units is given as a loading dose, then 6 units every hour until blood glucose is less than 10 mmol/l, then continued at 2 hourly intervals. As with intravenous insulin, higher doses are rarely needed.

Potassium and sodium bicarbonate

Potassium chloride administration should usually start at about the 2nd hour, preferably not before the serum potassium concentration is known. It should be withheld in exceptional cases of oliguria or anuria, or if the serum potassium value remains above 5 mmol/l. After the 2nd hour, or earlier if the initial serum potassium value is normal or less than 4 mmol/l, 20 mmol of potassium chloride should be added to each litre of saline. If the serum potassium value falls below 3 mmol/l, 40 mmol should be used in each litre. The exact amount should be determined by serial serum potassium measurements—every two hours at first, then every four—and serum potassium maintained between 4 and 5 mmol/l. An electrocardiographic monitor should be set up; there is, however, no substitute for serial potassium measurements.

Potassium chloride administration

Serum value: (mmol/l)	<3	3-4	4-5	>5
Administer:	40 mmol/l	30 mmol/l	20 mmol/l	0



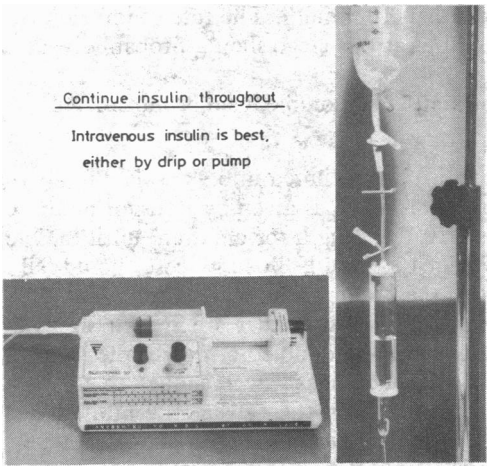
Sodium bicarbonate is not given unless the blood pH is less than 7·1 or the patient is shocked. If it is needed, aliquots of sodium bicarbonate (200 ml of 2·74% containing 65 mmol) with added potassium chloride (15 mmol potassium chloride) should be given over 30 to 60 minutes. This can be repeated if there is no response within one hour and if the patient's condition remains serious.

Treatment of the underlying condition—Underlying disease should be sought, especially respiratory or urinary infections, which may not be obvious at the beginning. Blood culture, culture of a mid-stream specimen of urine, and a chest radiograph are performed. There is no need to give antibiotics routinely. It is not usually difficult to distinguish a genuine surgical acute abdomen from the moderate pain and tenderness that are simply due to ketoacidosis.

Aketotic, hyperosmolar states—Management is exactly the same as that for ketoacidosis, except that 0·45% saline is given (if the serum sodium value is greater than 150 mmol/l), and a lower rate of insulin infusion (3 units/h) is often sufficient. In shocked and dehydrated patients prophylactic low-dose subcutaneous heparin is considered. Patients who develop this condition are often elderly or West Indian, and they often turn out to be non-insulin dependent.

Lactic acidosis—These patients are profoundly ill and the cause of the acidosis must be sought and rigorously treated. They are often very insulin resistant and need large amounts of sodium bicarbonate. A plasma Ketostix value less than ++ excludes ketoacidosis as a likely cause of the metabolic acidosis.

Management of diabetes during surgery



The chief principle of diabetic management through any crisis in which patients cannot eat or drink for any reason is to *continue insulin administration*. The best method is to give the insulin by continuous intravenous infusion, either by infusion pump, directly from the drip bag, or using a paediatric drip set. Traditional "sliding scales" are obsolete.

During surgery, management of the diabetic will depend on whether he needs insulin or not, and on whether the operation is major or minor.

Insulin-treated diabetics, minor operation

Minor operations may be managed in two ways: one regimen, using a minipump, is suitable for operations performed at any time of day; the other is appropriate only for early morning operations.

Minipump method

(1) Omit long-acting insulin the night before.
(2) Make up a solution of soluble insulin of 0·5 U/ml saline in a syringe.
(3) Set up an intravenous butterfly needle and minipump and start insulin at a rate of 0·5 U/h early on the day of operation.
(4) Check blood glucose concentration before and after operation and four hours later.
(5) Give normal evening insulin and then take down the pump.

This regimen may be used for an operation at any time of day and is very simple to use.

Early morning operations only

(1) Omit long-acting insulin the night before and all insulin on the morning of the operation.
(2) Give soluble insulin on return from theatre when the patient can take oral carbohydrate portions: give half to three-quarters of the total morning insulin requirement. This dose should be given by noon.
(3) Check blood glucose concentration before and after operation and four hours later.
(5) Give normal evening insulin.

If the diabetes is difficult to control (blood glucose >15 mmol/l) a change to intravenous administration via a pump should be considered.

Dextrose drip and variable-rate insulin infusion

(1) Give normal short-acting insulin with about 75% of the medium-acting insulin the night before operation.

(2) Early on the day of operation start an infusion of dextrose 5% or dextrose-saline and run at a *constant* rate appropriate to the patient's fluid requirements.

(3) Make up a solution of soluble insulin 1 U/ml saline in a syringe and infuse intravenously by a line piggybacked to the intravenous drip using a syringe pump. The infusion rate should normally be as shown in regimen 1, but in resistant cases use regimen 2 or 3.

Blood glucose	Soluble insulin infusion rate		
	Regimen 1	Regimen 2	Regimen 3
<4 mmol/l	0·5 U/h	1 U/h	2 U/h
4-15 mmol/l	2 U/h	4 U/h	8 U/h
>15 mmol/l	4 U/h	8 U/h	16 U/h
>20 mmol/l		Review	

Blood glucose is measured 2 hourly until stable, then 6 hourly.
Urine tests should also be performed as a safeguard against erroneous ward blood glucose readings.
Regimen 1 is satisfactory for most cases; very severely ill patients, shocked patients, and those on steroids or salbutamol infusions may need higher-dose infusions, such as regimens 2 or 3 or occasionally even more.
Never stop the insulin infusion since intravenous insulin lasts for only a few minutes.

Insulin-treated diabetics, major operations

For operations in which a patient is likely to be maintained on a drip for more than 12 hours a regimen is needed which can be continued for an indefinite period. Again there are two methods of administering the insulin: a variable-rate infusion using a pump, or, if this is not available, a glucose-insulin infusion.

Glucose-insulin infusion (when no pump is available)

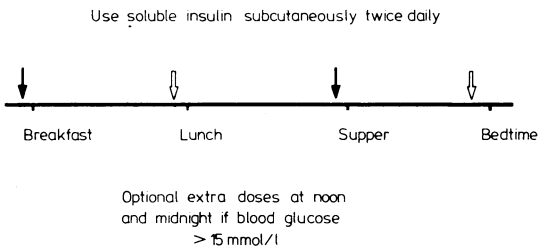
(1) Give normal short-acting insulin with about 75% of medium-acting insulin the night before operation.

(2) Begin an infusion of dextrose 5% containing soluble insulin 16 units per litre. Run it at a rate appropriate to the patient's fluid requirements. Adjust insulin dose as follows:

Blood glucose	Soluble insulin infusion
<4 mmol/l	8 U soluble insulin/l
4-15 mmol/l	16 U soluble insulin/l
>15 mmol/l	32 U soluble insulin/l
>20 mmol/l	Review

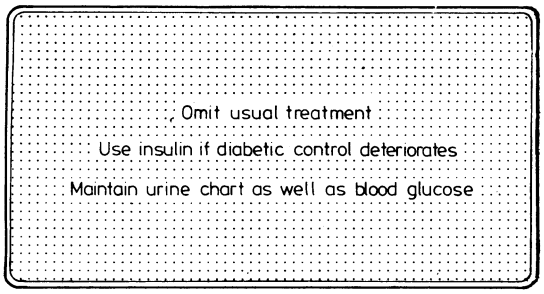
Blood glucose is measured 2 hourly until stable, then 6 hourly.
Urine tests should also be performed as a safeguard against erroneous ward blood glucose readings.

After recovery



Once the patient starts to eat and the intravenous drips have been removed, soluble insulin should always be given subcutaneously twice daily. It is best to start this regimen in the morning before breakfast. If blood glucose concentrations are high (more than about 17 mmol/l) additional doses should be given at noon or bedtime, or both. The regimen may need to be adjusted every day. Do not use a sliding scale.

Non-insulin dependent diabetics, all operations



Management of diabetics treated with diet or oral hypoglycaemic agents is more straightforward, so long as the diabetes is well controlled.

If the patient has well-controlled diabetes (random blood glucose value < 12 mmol/l):

(1) Omit the tablet on the day of operation.

(2) Check the blood sugar concentration soon after operation; if the blood glucose value is over 15 mmol/l start soluble insulin subcutaneously.

If the diabetes is poorly controlled (random blood glucose > 15 mmol/l) the patient should be started on insulin before the operation, using one of the regimens described above.

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