

# Unstable type 1 diabetes in adolescence

**Improving glucose control in a patient who has chronically unstable type 1 diabetes is an extremely intensive exercise for both patient and physician. Lessons learned in managing type 1 diabetes in adolescents generally apply to the disorder in children and adults also.**

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Type 1 diabetes differs from other diseases in that patients are required to make multiple daily biochemical assessments of their disease and then make decisions on the dosage of their medication, insulin, which has a therapeutic ratio (toxic dose/therapeutic dose) narrower than almost any other drug. Chronically unstable type 1 diabetes is characterised by either chronic hyperglycaemia or swings from normoglycaemia to both hyperglycaemia and hypoglycaemia. These instabilities increase the risks of long term complications.

This article focuses on chronically unstable diabetes in adolescence but the lessons learned in this age group apply, with variations, to the disorder in both childhood and later adult life.

## What the doctor knows about type 1 diabetes

Type 1 diabetes is a state of insulin deficiency following destruction of pancreatic beta cells by an autoimmune process that is polygenic and,

possibly, partly environmental in origin. The plasma glucose concentration is determined by the difference between the rate of glucose entry into the blood, from gut absorption from food and liver glucose release, and the rate of glucose exit from the blood into muscle, fat and other tissues. Some of these processes are influenced by insulin. Diet, exercise, stress (including emotional state) and sleep all affect glucose metabolism (Figure 1).

The condition can be complicated by retinopathy, nephropathy, neuropathy and macrovascular disease, although multiple daily insulin injections, careful attention to diet and frequent glucose monitoring, in addition to avoidance of tobacco consumption, have been shown to reduce the risk of these long term complications.

## What the adolescent knows about type 1 diabetes

In the eyes of an adolescent, type 1 diabetes is completely different from the pathophysiological

### IN SUMMARY

- The current treatment methods for type 1 diabetes are far from perfect; acknowledging this with the patient will aid compliance in the treatment of chronically unstable disease.
- Agreement should be reached between the patient and doctor about the need for regular measurement and recording of blood glucose levels.
- A list of management and lifestyle difficulties should be compiled by the patient and doctor together and the problems then addressed individually.
- Using the 'pattern recognition' approach to insulin choice and dosing should achieve fewer fluctuations in blood glucose levels than using the 'top-up' approach.
- Emotional, stress and educational problems are common causes of chronically unstable type 1 diabetes and should be identified and treated.
- The treating doctor's skills and attention to detail will be sharpened if he has experience of the devastating long term complications of diabetes.

situation described above. It is an uncool problem where parents and doctors expect at least three but usually four insulin injections each day and adherence to a diet lacking in spontaneity (to be eaten at six strict times during the day) and excluding the fun foods of adolescents.

As an adolescent with diabetes, you are also expected to prick your finger between two and six times a day, and then record the test results in a diary – revealing your daily deviations in diet to both your parents and your doctor. Even worse, your friends may see you injecting or finger pricking! The final humiliation is a coma, convulsion or a state of incoherence from hypoglycaemia in front of your friends. You therefore run high sugars even though you tend to feel tired and crabby, but this is certainly better than looking stupid in front of the guys.

And then you are told that if you don't jump through the diabetes management hoops perfectly, you may go blind or lose a leg. Plus, you may have difficulties in having healthy babies or, if you are a guy, lose your sexual performance.

Finally, unlike asthma or epilepsy, diabetes does not give you a holiday. It is there 24 hours each day, 365 days each year. If you miss just one insulin injection, you may end up in hospital with ketoacidosis, missing yet more time from school or work.

## Compliance

Realising the attitudes of normal adolescents, compliance with the expectations of doctors and dietitians in the management of diabetes must be regarded as a psychologically abnormal response. Compliance should probably be discarded as a concept, and certainly as an expectation of health professionals. The request for compliance should be replaced by an approach that identifies and improves, one at a time, the various obstacles and hurdles in the achievement of reasonable blood glucose control that are faced by a person of any age with type 1 diabetes.

The patient will only identify the obstacles to reasonable glucose control if the doctor acknowledges that the current treatment for type 1 diabetes is grossly imperfect and unphysiological. The label 'brittle diabetes' is an admission of failure by the doctor and a prescription of despair for the patient and, if improvement in control is desired, should never be used.



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## The emotion of guilt

Most people with type 1 diabetes experience guilt when they break the unrealistic regimen imposed upon them by their physician to minimise the risks of hypoglycaemia and long term complications. The experience of guilt is often followed by an overwhelming compulsion to repeat the behaviour.

People with type 1 diabetes should be educated that the treatment regimen, while designed for their own good, is severe and that breaking it simply confirms their psychological normality. The guilt–compulsion cycle of repetition must be explained and they should be encouraged to record aberrations in the treatment regimen, such as eating chocolate. The frequency of indiscretions will usually diminish if they do this, provided that the physician is non-judgemental.

## Diabetes record keeping

The recording of blood glucose test results, insulin doses, hypoglycaemic episodes, variations

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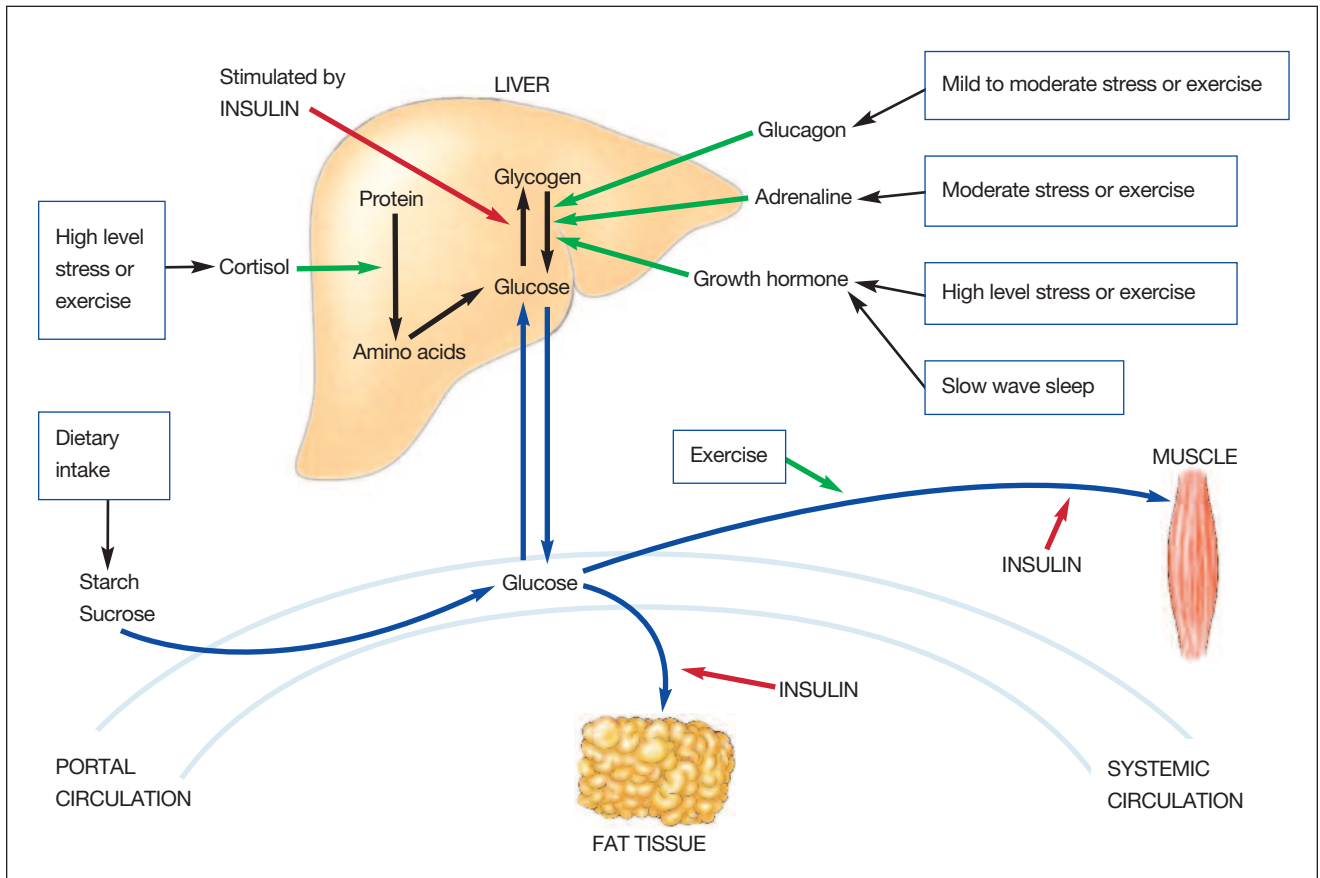


Figure 1. Glucose metabolism

in diet, intercurrent infections and stressful life events in a diabetes diary is an absolute prerequisite in the assessment and improvement of unstable diabetes. It is, however, one of the most odious duties for the patient. The patient and doctor must come to an agreement about the importance of the diary and the fact that it will be maintained, because improvement in control is unlikely to occur otherwise.

An electronic diary in a glucose monitor is not a satisfactory alternative for three reasons:

- an electronic diary rarely records life events such as infections, dietary indiscretions, stresses and menstruation
- by visually scanning across and down the manually kept glucose test results

columns, the physician can see daily patterns and their relation to insulin doses, periods of increased or reduced exercise (such as at weekends) or menstruation, for example, that would never become obvious in an electronic record

- a manual spreadsheet record also allows the person with diabetes to detect patterns in glucose fluctuations that may be related to diet or to life events, providing valuable feedback.

### Management factors in unstable diabetes

#### Diet

The concept of the optimal diet for people with type 1 diabetes has changed dramatically over the past decade. We are now aware that starch in different

foods is digested and absorbed as glucose at greatly differing rates.

#### Glycaemic index

The measure of a starchy food's rate of absorption as glucose is called its glycaemic index (GI), with glucose having a value of 100. Many previously 'forbidden foods', some sweets and many desserts have been found to have a relatively low GI and can now be included in the diabetic diet without causing deterioration in glycaemic control, thereby breaking some of the monotony and restriction of the diet. Others, such as potato, can cause a marked rise in plasma glucose and contribute to poor glycaemic control.

All patients with unstable diabetes should have their nutritional knowledge

updated by a professional dietitian. Patients should also be encouraged to purchase one of Professor Jennie Brand-Miller's books on the glycaemic index, such as *The New Glucose Revolution* (written with Kaye Foster-Powell and Stephen Colagiuri) or the accompanying pocket guides (all published by Hodder Headline, Sydney).

### Exercise

Moderate physical exercise produces a

moderate increase in the secretion of the stress hormones glucagon, adrenaline and growth hormone, all of which act on the liver to increase liver glucose production by stimulating hepatic glycogen breakdown to glucose (see Figure 1). The rise in liver glucose release is less than the increase in muscle glucose uptake and the plasma glucose therefore falls and hypoglycaemia may ensue if additional food is not eaten.

More severe exercise, above 90% of

maximal exercise capacity, stimulates a greater outpouring of glucagon, adrenaline and growth hormone and also increases cortisol secretion. Liver glucose production is increased by a greater extent than muscle glucose uptake and the plasma glucose will rise.

Paradoxically, exercise on waking before insulin and before breakfast will also cause the plasma glucose to rise because liver glucose production is accelerated pre-dawn by the physiological

## Steps in improving chronically unstable type 1 diabetes in adolescents\*

### Adolescent presents with chronically unstable type 1 diabetes

#### At first consultation:

- Explain and apologise for the imperfect nature of insulin replacement therapy
- Ask the patient to list his or her frustrations with diabetes
- Explain the need for manually keeping a manual diabetes diary
- Explain the pattern recognition insulin dosing regimen
- Exclude coeliac disease, gastric stasis, infections and thyroid disease

#### Diet

- Refer to a dietitian for updating of nutritional knowledge

#### Treatment

- Commence intensive insulin therapy, determining the choice of insulin by the patient's previous responses
- Encourage the patient to manually keep a diabetes diary, recording life events, diet deviations, exercise taken and frequent blood glucose test results (varying testing between before meals and bedtime and 1.5 to 2 hours after meals)

#### Support

- Explore emotional state and family, partner, school and workplace dynamics, enlisting the help of a few others:
  - family member or partner
  - social worker
  - psychologist or psychiatrist
  - diabetes educator
  - summer camp
- Resolve issues of stress and conflict, and treat depression

#### Ongoing care

- Monitor and provide frequent feedback on the patient's progress by:
  - requesting the patient faxes copies of diary pages two to seven times weekly
  - having face-to-face contact with the patient every two to four weeks until control optimised
- Change type of insulin if glucose response is unsatisfactory
- Identify life events affecting glucose control and take them into account in the treatment regimen

\*These steps also apply, with variations, to children and adults.

continued

mid-sleep surge in growth hormone secretion.

Explanation of these phenomena to the person with type 1 diabetes will cause a glow of enlightenment to spread across his or her face and acceptance that some of the common frustrating experiences are now explicable and all is not hopeless.

**Insulin dosing: top-up or pattern recognition approach?**

One of the common causes of glycaemic fluctuations in type 1 diabetes is the use of the ‘top-up’ or ‘tail chasing’ approach to insulin dosing, whereby an insulin dose is determined by the pre-dose blood glucose level. This approach seems intuitive to many patients and doctors.

Fewer fluctuations in plasma glucose levels will be achieved with a change to the ‘pattern recognition’ approach to insulin dosing. In this approach, a particular insulin dose is determined by the efficacy of that dose during the time

period of action of that dose over the preceding four to seven days.

For example, if a person with type 1 diabetes woke with an elevated glucose of 16 mmol/L, the pattern recognition approach would suggest that, if this was a regular event, the pre-bedtime dose should be increased or a slower and longer acting insulin should be used at bedtime. In the same situation, the top-up approach would increase the breakfast insulin dose, causing a fall in glucose before lunch; the lunch insulin dose would then be decreased, causing a rise in glucose late afternoon and an increase in the dinner dose of insulin; the pre-bed glucose level would then most likely fall, tempting a reduction in the bedtime dose so that the pre-breakfast glucose level would be just as high or higher than the previous morning.

Some people with longstanding type 1 diabetes have great difficulty in overcoming their compulsion to adjust an

insulin dose on the basis of the pre-dose glucose level. The top-up approach is only appropriate when hyperglycaemia is the result of an acute infection, an operative procedure or acute stress.

**Reducing food intake to control hyperglycaemia – a common error**

It is common and understandable that people with type 1 diabetes attempt to control hyperglycaemia by restricting food intake. This, however, leads to a further increase in fat breakdown and a further increase in ketone formation that can antagonise insulin action and cause nausea. Patients with diabetes should be educated that their food intake should be determined by their daily bodily requirements, including energy expenditure and growth, and not by their glucose levels.

**Fasting hyperglycaemia**

Overnight blood glucose homeostasis is achieved in nondiabetic individuals by

**Table 1. Choice of pre-meal insulin type**

Insulin type	Tradename	Duration of action	Advantages	Disadvantages
Lispro	Humalog	Very short acting	Rapid onset of action Little day-to-day variation in effect	Duration of action very short , so blood glucose levels may rise before the next meal
Aspart	NovoRapid	Very short acting	Rapid onset of action Little day-to-day variation in effect Action 1 hour longer than lispro	Duration of action short, so blood glucose levels may rise before the next meal
Neutral (human)	Actrapid, Humulin R	Short acting	Action long enough to cover lunch to dinner period	A 20- to 30-minute gap between injection and eating preferable Some day-to-day variation in effect May overlap with bedtime insulin, increasing risk of nocturnal hypoglycaemia
Neutral (bovine)	Hypurin Neutral	Short acting	Slower and longer action if desired – rarely used	Not available for pen injectors, hence syringes must be used More day-to-day variation in effect May overlap with bedtime insulin, increasing risk of nocturnal hypoglycaemia

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the secretion of growth hormone during levels 3 and 4 sleep (slow wave or non-REM sleep), accelerating the breakdown of liver glycogen to glucose, causing a pre-dawn rise in blood glucose.

In type 1 diabetes, the difficulty is to achieve overnight blood insulin concentrations that do not cause hypoglycaemia between 12.00 a.m. and 2.00 a.m. but which control the pre-dawn surge in liver glucose production. A pre-bed supper is almost always essential in the achievement of this aim. If sleep is disturbed, slow wave sleep is not achieved, little growth hormone is secreted and hypoglycaemia ensues.

Research has shown that fasting hyperglycaemia is not due to counter-regulatory rebound from hypoglycaemia, the so called 'Somogyi effect'. Nocturnal hypoglycaemia stimulates secretion of counter-regulatory stress

hormones that almost always cause the blood glucose to rise only to low-normal or normal levels.

**Choice of insulin type and regimen**

Glycaemic control and fluctuations can rarely be improved on twice daily insulin therapy. Most people with type 1 diabetes will only achieve significant improvement in glucose control with intensive insulin therapy comprising a short acting insulin before each main meal and a longer acting insulin usually before bed, but occasionally with the evening meal and rarely with breakfast.

The main criteria in the choice of insulin are onset and duration of action and variability in efficacy from dose to dose or from day to day. The most common insulin-induced cause of glucose instability is variability in action or in duration of action of the evening longer

acting insulin. The properties, advantages and disadvantages of short acting and long acting insulins are outlined in Tables 1 and 2.

Pump infusion of insulin subcutaneously will solve almost all insulin problems but requires enormous dedication from the patient and is very expensive.

The steps to improve chronically unstable type 1 diabetes are outlined in the flowchart on page 67.

**Illnesses destabilising type 1 diabetes**

Infections that cause fluctuations in glucose levels, such as urinary tract infection (often asymptomatic in the presence of a neuropathic bladder) or low-grade cholecystitis, are uncommon causes of unstable diabetes but warrant exclusion.

Coeliac disease, which affects at least 2% of people with type 1 diabetes, and

**Table 2. Choice of pre-bed insulin type**

Insulin type	Tradename	Duration of action	Advantages	Disadvantages
Isophane (human)	Humulin NPH, Protaphane	Intermediate	Gives the most consistent results in the majority of patients	Action may be too strong around 1200 a.m. to 2.00 a.m. Day-to-day variability in some patients
Lente (human)*	Humulin L, Monotard	Intermediate	In 20% of patients, this type gives most consistent results	Not available for pen injectors, hence syringes must be used Day-to-day variability in most patients
Isophane (bovine)	Hypurin Isophane	Long acting	Longer duration of action than isophane (human)	Not available for pen injectors, hence syringes must be used Day-to-day variability in most patients
Ultralente (human)†	Humulin UL, Ultratard	Long acting	Longer duration of action than lente (human)	Not available for pen injectors, hence syringes must be used The most day-to-day variability in duration and intensity of action
Glargine insulin	Lantus	Long acting	Very even action over 24 hours	Not yet available on PBS, very expensive, must be imported

\*Lente also known as zinc suspension. †Ultralente also known as zinc suspension crystalline.

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delayed gastric emptying from autonomic neuropathy can lead to erratic absorption of food and poor glucose control.

### Stress, conflict and depression

Family, partner, school or work stress and conflict are common causes of chronically unstable diabetes. Elucidation of these problems will often only be achieved once a trusting and nonjudgemental relationship has been established between the doctor and the person with diabetes.

Depression is also very common, and improvement in glycaemic control will only be achieved once the depression has been acknowledged as existing and then treated.

Psychologists, psychiatrists, social workers and family members can be very helpful in improving depression and stress but it can be counter-productive to involve too many people. Summer camps for children and adolescents with diabetes are among the most helpful agencies in improving acceptance of this demanding disease.

### Organisational barriers to improved glucose control The diabetes team

For more than two decades, type 1 diabetes has tended to be managed by teams of health professionals – GPs, endocrinologists, dietitians, diabetes educators, psychologists and social workers, each adding the value of their own unique skills to the patient's management. This approach, however, can lead to an escapist tendency to assume that diabetic instability is due to a problem in the area of another health professional rather than in one's own area.

Every person with type 1 diabetes needs one professional who takes ultimate responsibility. This professional ideally should be an endocrinologist as the complexities of type 1 diabetes management can rarely be fully mastered by the GP, particularly in unstable situations. However, the GP is often the key to

the detection of the patient's own or his or her family's emotional and stress problems that are a common cause of unstable glucose control. The diabetes educator may occasionally fill this role.

### The adolescent to adult transition

Adolescent and childhood diabetes is mostly managed by doctors who never see the devastating results of poor glycaemic control: blindness, dialysis or offspring with severe congenital abnormalities. Adolescent and childhood diabetes physicians then hand over their patients to adult diabetes physicians at an emotionally tempestuous time in the young person's life: around the end of schooling and the beginning of employment or tertiary education.

Adult physicians usually expect a higher degree of patient self-control than childhood physicians – high expectations from a young adult with whom they do not have a long-established relationship, at a time of rebellion and rejection of adult expectations and when complications are likely to first appear. Consequently, despite so called 'hand-over clinics', the patient is often lost to follow up for a number of years, obtaining repeat insulin prescriptions from their GP or anonymous medical centres, presenting again in the mid-twenties with ketoacidosis or a retinal haemorrhage and irreversible damage. This system could not be designed to give a worse long term outcome for young people with diabetes.

### Preferred time of transition

Preferably, the hand-over from childhood to adult diabetes physician should take place on entry to high school in order that a therapeutic relationship with an adult physician is established before the turmoil of adolescence. The hand-over could, however, take place at around 25 to 26 years of age, a stage of life when even immature young people become cognisant of the future, a fact recognised by the motor vehicle insurance industry. This, in reality, is the time when many young adults adopt adult endocrinologist care after a gap of six to eight years.

### In the future

In the longer term, endocrinologists should be trained as 'from diagnosis to the grave' paediatric–adult specialists whose skills and attention to detail will inevitably be sharpened when one of their long term diabetic patients develops retinopathy or renal failure 10 to 20 years after they first met at diagnosis. This change in training is already occurring in the USA.

### Conclusion

The improvement of glucose control in patients with chronically unstable type 1 diabetes is an extremely intensive exercise for both the patient and the doctor. However, the effects on wellbeing and performance in the short term and the reduction in complications in the long term make it one of the most worthwhile exercises in medical practice. **MT**

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