

# Sick day care in children with type 1 diabetes

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In children with type 1 diabetes, intercurrent illness can easily lead to complications such as ketoacidosis, dehydration, uncontrolled hyperglycaemia and hypoglycaemia. A sick day management plan helps avoid and treat these complications.

A 'sick day' in children with type 1 diabetes refers to a period of intercurrent illness that affects glycaemic control and potentially requires adjustments to the child's usual management practices. During sick days, the blood glucose level (BGL) may be minimally affected, high or low. The child may develop ketoacidosis or dehydration. A sick day management plan and sufficient supplies in the home to implement the plan may help children and their parents minimise these complications. An important decision for the treating physician is whether the child can be treated safely at home or requires hospital admission.

Children and adolescents with diabetes and optimal glycaemic control do not experience more illness or infections than those without diabetes. However, there is some evidence that children with suboptimal glycaemic control have impaired leucocyte function, increasing their susceptibility to infection and delaying recovery.<sup>1</sup>

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Illnesses that cause vomiting and diarrhoea may lower BGL because of poor oral intake, poor absorption or delayed gastric emptying. However, importantly, vomiting in a child or adolescent with diabetes should always be considered a sign of insulin deficiency until proven otherwise. The release of stress hormones such as adrenaline during illness promotes gluconeogenesis and insulin resistance, thus causing high BGLs.<sup>2</sup> Illness may increase ketone production if there is insufficient glucose available for intracellular metabolism because of inadequate food uptake or a relative or absolute insulin deficiency. Indeed, the risk of diabetic ketoacidosis in patients with established type 1 diabetes is reported to be as high as 10% per patient per year.<sup>3</sup> Often insulin requirements are higher during the incubation period of an infection and for a few days after the illness has passed because of insulin resistance.<sup>4</sup> It is important to reassure parents that this is a transient condition and does not indicate worsening glycaemic control.

## General principles of sick day management

The general principles of sick day management for children with type 1 diabetes are summarised in Box 1. Suggested supplies that should be kept in the home for sick day management are listed in Box 2.

### Treat the underlying illness and provide symptomatic relief

The underlying illness should be treated as it would be for a child without diabetes, including use of analgesics, antipyretics and other measures of symptomatic relief. Any specific illnesses should be treated as indicated; for example, antibiotics should be given for otitis media.<sup>3</sup>

### 1. GENERAL PRINCIPLES OF SICK DAY MANAGEMENT FOR CHILDREN WITH TYPE 1 DIABETES.

- Treat the underlying precipitating illness
- Increase frequency of blood glucose and ketone monitoring
- Do not stop insulin but adjust dose if needed
- Monitor and maintain fluid balance and calorie intake
- Consider glucagon administration
- Educate patients and caregivers soon after diabetes diagnosis about sick day guidelines, including insulin adjustments; review annually

#### Monitor blood glucose and ketone levels regularly

BGLs should be monitored frequently, as often as every one to two hours.<sup>2</sup> In addition, measurement of ketones in blood or urine helps to guide sick day management. Ketones are produced by the liver as an alternative energy source when there is a lack of glucose for intracellular metabolism, caused, for example, by starvation or a relative or absolute insulin deficiency.

The ketone levels considered to be elevated in children with diabetes vary slightly between guidelines. For example, the International Society of Paediatric and Adolescent Diabetes considers a blood beta-hydroxybutyrate (BOHB) level over 0.5 mmol/L as abnormal, with levels in the range 0.6 to 0.9 mmol/L considered 'minimal' ketones.<sup>5</sup> In contrast, Australian clinical guidelines on type 1 diabetes set a blood BOHB level of 1.0 mmol/L as the cut off for abnormal.<sup>3</sup>

When considering ketone measurements in blood versus urine, it is important to remember that the blood BOHB level normalises sooner than the urine ketone level during resolution of ketosis.<sup>5</sup> Thus monitoring of blood BOHB potentially prevents overtreatment with insulin. Blood BOHB measurement may also be useful in very young children or when urine samples are difficult to obtain. Households should maintain sufficient supplies for monitoring BGL and ketone levels.

#### Adjust insulin therapy as required

Insulin therapy should not be stopped completely but may need to be adjusted depending on BGL and ketone levels (see Table 1).<sup>3</sup> The target BGL is between 4 and 8 mmol/L, with blood ketone level less than or equal to 0.5 mmol/L, although Australian guidelines regard a blood ketone level less than 1.0 mmol/L as acceptable in the situation of illness.<sup>3</sup>

#### High blood glucose levels

Additional insulin doses for children with hyperglycaemia (BGL greater than 8 mmol/L) are described in Table 1. It is recommended initially to adjust the short- or rapid-acting insulin dose and not the long-acting insulin dose. The adjustment dose is calculated as a percentage of the total daily dose – the sum of

### 2. RECOMMENDED SUPPLIES FOR SICK DAY MANAGEMENT AT HOME

- Short- or rapid-acting insulin (pens, syringes)
- Glucometer, lancet, test strips
- Ketone testing strips (blood, urine)
- Glucose tablets
- Carbohydrate-containing drinks
- Glucagon injection
- First aid kit that includes paracetamol and ibuprofen
- Sick day management plan
- Health professional contact numbers

all insulin doses (long-, short- or rapid-acting) usually taken per day.

For example, recommended management for a child with a BGL of 17.4 mmol/L and a blood ketone level of 1.6 mmol/L is:

- to give a supplemental insulin dose of 15 to 20% of the total daily dose
- to monitor BGL and ketones hourly
- to adjust the regimen according to response (see Table 1).

#### Low blood glucose levels

Hypoglycaemia (BGL less than 4 mmol/L) is often caused by viral gastroenteritis and associated with nausea and vomiting, with or without diarrhoea. The total daily dose of insulin may need to be reduced by 20 to 50% (usually through reduction of basal and prandial insulin doses), but insulin deficiency needs to be avoided to prevent excess ketone production.<sup>5</sup> It is essential to maintain hydration with appropriate carbohydrate-containing fluids (fruit juice, soft drinks, cola, sports drinks or proprietary dextrose and electrolyte solutions) and to pay attention to urine output. Intravenous fluids will be needed if nausea, vomiting and diarrhoea persist.

The presence of moderate ketones in the context of low or normal BGLs can be due to starvation and can be treated with carbohydrate-containing food and drink and adjustment of the insulin dose (see Table 1).

#### Considerations for insulin pump therapy

Patients on insulin pumps use only rapid-acting insulin, with no long acting-insulin. With pump use, diabetic ketoacidosis can develop rapidly because of either interruption of insulin delivery or intercurrent illness when the dose of insulin is not adjusted.<sup>3</sup> If hyperglycaemia is present, particularly in the presence of ketones, then the pump or delivery system needs to be checked for pump malfunction or failure. The infusion set, tubing and insulin reservoir need to be changed.<sup>5</sup> It is essential to give an immediate injection of short-acting insulin via syringe or pen in the situation of hyperglycaemia with ketosis to be

**TABLE 1. INSULIN AND FLUID THERAPY FOR SICK DAY MANAGEMENT IN CHILDREN WITH TYPE 1 DIABETES<sup>3\*</sup>**

Blood glucose (mmol/L)	Ketones in blood (mmol/L) <sup>†</sup> or urine	Supplemental insulin dose (can be given up to 2-hourly) <sup>*</sup> or other treatment	Timing of review	Fluid intake
<4.0	<1.0 or negative	<ul style="list-style-type: none"> <li>Insulin dose reduction may be required</li> <li>Consider mini-dose glucagon to prevent hypoglycaemia if vomiting, diarrhoea or reduced carbohydrate intake</li> </ul>	<ul style="list-style-type: none"> <li>Check every 20 to 30 minutes until BGL &gt;4 mmol/L</li> <li>Supervised medical care required if ketones positive and BGL low</li> </ul>	<ul style="list-style-type: none"> <li>Take sweetened fluids or quick acting carbohydrate (or both)</li> <li>Hospital admission for IV fluids may be needed if BGL cannot be maintained</li> </ul>
	≥1.0 or positive	<ul style="list-style-type: none"> <li>Priority is to increase BGL with fluid and carbohydrate</li> </ul>		
4.0 to 8.0	<1.0 or negative/trace	<ul style="list-style-type: none"> <li>No change to insulin</li> </ul>	<ul style="list-style-type: none"> <li>Every 2 hours: BGL and ketones</li> </ul>	<ul style="list-style-type: none"> <li>Give sweetened fluids or extra carbohydrate to maintain or increase BGL</li> </ul>
	1.0 to 1.4 or small amount	<ul style="list-style-type: none"> <li>No change to insulin; ketones indicate carbohydrate and insulin deficiency</li> </ul>		
	≥1.5 or moderate/large amount	<ul style="list-style-type: none"> <li>5% supplemental insulin may be required</li> </ul>		
>8.0 to 15.0	<1.0 or negative/trace	<ul style="list-style-type: none"> <li>BGL may fall without extra insulin</li> <li>If BGL persistently elevated, consider 5% supplemental insulin</li> </ul>	<ul style="list-style-type: none"> <li>Every 2 hours: BGL and ketones</li> </ul>	<ul style="list-style-type: none"> <li>Give sweetened fluids or extra carbohydrate to maintain BGL</li> </ul>
	1.0 to 1.4 or small amount	<ul style="list-style-type: none"> <li>If ketones persistently elevated, consider 5 to 10% supplemental insulin</li> </ul>		
	≥1.5 or moderate/large amount	<ul style="list-style-type: none"> <li>10% supplemental insulin dose</li> </ul>		
>15.0	<1.0 or negative/trace	<ul style="list-style-type: none"> <li>5 to 10% supplemental insulin dose</li> </ul>	<ul style="list-style-type: none"> <li>Every 1 hour: BGL and ketones</li> </ul>	<ul style="list-style-type: none"> <li>Give sweetened fluids or extra carbohydrate to maintain BGL</li> </ul>
	1.0 to 1.4 or small amount	<ul style="list-style-type: none"> <li>10 to 15% supplemental insulin dose</li> </ul>		
	≥1.5 or moderate/large amount	<ul style="list-style-type: none"> <li>15 to 20% supplemental insulin dose</li> </ul>		

ABBREVIATION: BGL = blood glucose level; IV = intravenous.

\* Based on Craig ME, Twigg SM, Donaghue KC, et al; Australian Type 1 Diabetes Guidelines Expert Advisory Group. National evidence-based clinical care guidelines for type 1 diabetes in children, adolescents and adults, 2011.<sup>3</sup>

<sup>†</sup> Blood 3β-hydroxybutyrate level.

<sup>‡</sup> Refers to percentage of total daily insulin dosage given as short- or rapid-acting supplemental insulin dose. Exercise caution with supplemental insulin doses in the presence of a BGL <8 mmol/L – advise increasing sweetened fluid intake first.

certain that insulin is being administered. BGL and ketones need to be retested within 30 to 60 minutes.

Once stable insulin delivery through the pump has been re-established, the basal insulin rate may be increased from 100% to 150% depending on BGL and ketone results. Correction boluses may also have to increase by 10 to 20% during the period of illness. Pump settings need to be reset after the situation has stabilised (Table 2).<sup>5</sup>

Patients using insulin pumps and their caregivers need regular education about the need and strategy for administering subcutaneous insulin in case of a pump failure. This can be in the form

of multiple daily injections following a basal-bolus regimen. The dose of long-acting insulin can be calculated according to the total basal insulin delivered by the pump. For example, if the total basal insulin for a patient is 10 units then that amount can be given as long-acting insulin. Five to 10% of the total daily dose can be given as a dose of short-acting insulin every three to four hours. Pump supplies should always be readily available.<sup>3</sup>

**Maintain hydration and calorie intake**

Replacing meals with easily digestible food and glucose-containing fluids provides energy and prevents further ketosis.

Sick day management supplies can include jellybeans, glucose tablets and carbohydrate-containing fluids (fruit juice, soft drinks, cola, sports drinks or proprietary dextrose and electrolyte

solutions) to prevent hypoglycaemia.<sup>5</sup> Glucose tablets contain a monosaccharide that raises the blood sugar quickly but should not be given to children younger than 5 years because of the risk of

choking.<sup>6</sup> Three to four glucose tablets are roughly equivalent to 15 to 20 g of carbohydrate. In children with diarrhoea, care should be taken with hypertonic or sweetened fluids; dilution with water up to one to five times may be required for optimum absorption.

**TABLE 2. SPECIFIC SICK DAY MANAGEMENT FOR CHILDREN USING AN INSULIN PUMP WITH BGL >15 MMOL/L<sup>5</sup>**

Ketone level		Management
Blood (mmol/L)	Urine	
<0.6	Negative/small amount	<ul style="list-style-type: none"> <li>• Use injected insulin given with a syringe or pen to deliver the correction bolus dose if problems with the injection site or pump are suspected</li> <li>• Test BGL hourly</li> <li>• Maintain fluid balance orally or with intravenous fluids if needed</li> <li>• Replace the infusion set and cannula if there is no response using the pump</li> <li>• If BGL is lower after 1 hour, recheck again after 1 to 2 hours and decide whether another correction bolus dose is needed</li> <li>• Liaise with diabetes pump team and stay in contact if deemed necessary</li> </ul>
≥0.6 or suspected pump failure	Moderate/large amount	<ul style="list-style-type: none"> <li>• Use injected insulin given with a syringe or pen to deliver the correction bolus dose</li> <li>• Test BGL hourly</li> <li>• Maintain fluid balance orally or with intravenous fluids if needed</li> <li>• Replace the infusion set, cannula and insulin in the pump</li> <li>• If after 2 hours the BGL is improved, pump use can be resumed</li> <li>• If BGL remains high, ketones persist or nausea, vomiting or abdominal pain develop then liaise with diabetes pump team or refer for immediate hospital assessment</li> </ul>

ABBREVIATION: BGL = blood glucose level.

**TABLE 3. RECOMMENDED DOSE FOR MINI-DOSE GLUCAGON RESCUE<sup>3</sup>**

Age (years)	Glucagon dose			
	Micrograms (µg)	Milligrams (mg)	Millilitres (mL)	Units (on insulin syringe)
≤2	20	0.02	0.02	2
>2 to <15	10 per year of age	0.01 per year of age	0.01 per year of age	1 per year of age
≥15	150	0.15	0.15	15

**Consider glucagon**

A glucagon injection is used in severe cases of hypoglycaemia when the person is unconscious or unable to swallow safely. As a part of diabetes education, families receive training in the use of glucagon, which is available in a hypoglycaemia kit containing 1 mg glucagon. Injections can be given subcutaneously or intramuscularly; intravenous administration is reserved for health care professionals. If hypoglycaemia and nausea or food refusal persist, a modified, smaller than usual glucagon dose may reverse the hypoglycaemia and enable oral fluid intake to be re-established (‘mini-dose glucagon rescue’, Table 3).<sup>3</sup>

**Regularly review management plan and education**

At each consultation with the diabetes team, the current management plan, availability of ambulance cover and contact arrangements must be reviewed and updated if necessary. Key areas of sick day management, along with preparation of a sick day care plan, should be reviewed regularly to help patients avoid complications such as ketoacidosis, dehydration, uncontrolled hyperglycaemia and hypoglycaemia. It is also useful for GPs to review this information with patients.

**Role of the GP – home versus hospital?**

GPs helping families care for sick children with type 1 diabetes at home should provide clear guidance, following the above steps. In Australia, diabetes services provide emergency hotlines for assistance. Sick day management at home should be discontinued, and

emergency presentation or transfer to hospital arranged if:

- vomiting persists, especially if it is frequent or becomes bile-stained
- ketones are present and levels are increasing
- BGL continues to rise despite treatment, or
- the child or adolescent becomes more unwell, drowsy, disoriented or confused.<sup>3</sup>

Irrespective of clinical findings, hospital admission is recommended if the caregivers appear exhausted or uncertain about how to handle the situation or if the nature of the illness is unclear.

### Conclusion

GPs have an important role in providing sick day management to patients with type 1 diabetes. Detailed recommendations are available outlining the initial steps.<sup>3,5,6</sup> It is essential to provide education and management plans for sick day care to patients and their families. In Australia, specialist teams are available to assist on a 24/7 basis. Patient transfer to hospital should be considered in a timely manner if complications are expected.

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COMPETING INTERESTS: None.

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