

Evidence Summary

Hypoglycaemia and hyperglycaemia

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Hypoglycaemia and hyperglycaemia

Hypoglycaemia and hyperglycaemia occur in both type 1 and type 2 diabetes. Hypoglycaemia is a medical emergency and must be treated promptly. Hyperglycaemia if not recognised and treated early, will lead two types of medical emergencies, known as diabetic ketoacidosis and hyperglycaemic hyperosmolar state.

The aim of this section is to provide an overview of these acute complications in the context of the home / community setting to prevent deterioration and risk of harm.

Refer to the Evidence Summary - '*Hospitalisation*' for more information about managing hypoglycaemia, hyperglycaemia, diabetic ketoacidosis and hyperglycaemia hyperosmolar state in a hospital or health service setting.

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Hypoglycaemia

In patients with diabetes, hypoglycaemia is defined as all episodes of an abnormally low glucose concentration (with or without symptoms) that expose the individual to harm. The value at which this occurs is generally defined at below 4 mmol/L but can differ according to the age of the person, type and duration of diabetes and whether there are any associated medical conditions.^{1, 2}

Hypoglycaemia can be very frightening for the person with diabetes and their family. Furthermore, hypoglycaemia can lead to injury such as falling, an accident while driving and or death. Health professionals play an important role in educating people so they understand their risks, develop prevention strategies and manage hypoglycaemia events when they do occur.

Regulation of glucose

In people without diabetes, the extracellular supply of glucose is carefully regulated primarily by insulin and glucagon. In the fasting state, when glucose cannot be obtained from the intestinal absorption of food, glucose counter-regulatory mechanisms prevent or rapidly correct falling blood glucose concentrations by:

- > decreasing insulin secretion
- > increasing glucagon secretion and
- > increasing epinephrine secretion.

Cortisol and growth hormone contribute only if the hypoglycaemia episode persists for several hours. These hormones limit glucose utilization and enhance hepatic glucose production.

In people with diabetes who are treated with insulin and/or sulfonylureas, hypoglycaemia is typically the result of the interplay of absolute or relative therapeutic insulin excess and compromised physiological and behavioural defences against falling blood glucose levels. The protective responses are impaired due to:

- > The inability to suppress insulin release in people with type 1 diabetes and those with longstanding type 2 diabetes.
- > The loss of the glucagon response to hypoglycaemia in people with type 1 diabetes and more slowly in type 2 diabetes.
- > The epinephrine response to hypoglycaemia being also weaker in many patients, which causes defective glucose counter-regulation.

Diabetes medications such as metformin, alpha-glucosidase inhibitors, thiazolidinediones, glucagon-like peptide-1 (GLP-1) receptor agonists, dipeptidyl peptidase-4 (DPP-4) inhibitors and sodium-glucose co-transporter 2 (SGLT2) inhibitors do not cause hypoglycaemia. However, they increase the risk if used with insulin and/or sulfonylureas.

Impact of hypoglycaemia

In people with type 1 diabetes, hypoglycaemia occurs frequently and numerous episodes of asymptomatic and/or symptomatic hypoglycaemia may occur each week.

Severe hypoglycaemia events, have been reported to range from 62 to 320 episodes per 100 patient-years in type 1 diabetes.³

In people with type 2 diabetes, hypoglycaemia is less common. Among people prescribed sulfonylureas, hypoglycaemia is most often reported in those taking long-acting medications. Hypoglycaemia is relatively uncommon during treatment with basal insulin. However, as the intensity of insulin increases (eg basal bolus insulin), an increase in the prevalence of hypoglycaemic events have been reported.⁴

Hypoglycaemia, outside of a meal or snack time is rare in women with gestational diabetes.

Clinical features of hypoglycaemia

The symptoms of hypoglycaemia can be classified into two groups:

1. Symptoms in response to adrenaline or the sympathetic nervous system (pale skin, sweating, shakiness, tingling especially around the lips, palpitations and a feeling of anxiety).
2. Symptoms due to decreased glucose in the brain (difficulty concentrating, confusion, inappropriate behavioural and psychological reactions, drowsiness, ultimately seizures and coma).

Hypoglycaemia can be defined on the basis of physiology using the terminology mild, moderate or severe (Table 1).

Table 1

Mild	Moderate	Severe
Capable of self-treating	Unable to recognise the hypo but able to self-treat when prompted	Not capable of self-treatment
Tremors, palpitation, sweating, hunger, fatigue	Headache, mood changes, low attentiveness	Conscious or unconscious
Adrenergic	Neuroglycopenic	Neuroglycopenic

Hypoglycaemia at night is often slept through and not noticed. Symptoms of unnoticed nocturnal hypoglycaemia can include:

- > morning headaches
- > hangover type feeling on waking
- > nocturnal sweating.

Causes of hypoglycaemia

Hypoglycaemia is a risk for people who are taking insulin and/or sulfonylureas. There are a number of possible causes of hypoglycaemia that have been identified:

- > too much basal insulin
- > delay in eating after injection of rapid acting insulin
- > missing a meal after injection of rapid acting insulin
- > miss match between rapid acting insulin and carbohydrate intake
- > more strenuous physical activity than usual
- > unplanned physical activity
- > excessive alcohol intake
- > fasting, vomiting or diarrhoea
- > during or after breastfeeding.^{1, 2}

Young children with type 1 diabetes and the elderly are noted as particularly vulnerable to clinically significant hypoglycaemia because of their reduced ability to recognise hypoglycaemic symptoms and effectively communicate their needs.

Impaired hypoglycaemic awareness

Hypoglycaemia unawareness is where the person with diabetes does not detect the warning signs and is at risk of developing severe hypoglycaemia. Unawareness or a reduction of hypoglycaemia symptoms occurs more frequently in people who have had diabetes for many years or in people who experience frequent hypoglycaemia, or who maintain lower blood glucose targets.

Hypoglycaemia unawareness or one or more episodes of severe hypoglycaemia should trigger assessment.

People with type 1 diabetes and those with type 2 diabetes prescribed insulin with hypoglycaemia unawareness or an episode of clinically significant hypoglycaemia are recommended to raise their glycaemic targets to avoid hypoglycaemia for at least several weeks in order to partially reverse hypoglycaemia unawareness and reduce risk of future events.

Education and support for partners/carers and the patient is important in managing hypoglycaemic unawareness.¹

Hypoglycaemia management

Hypoglycaemia must be treated promptly. The following is a suggested action plan for the self-treatment of people with hypoglycaemia in the community. For further information, refer to the CHSA Protocol – ‘Treatment of hypoglycaemia in patients with diabetes’ and Evidence Summary - ‘Hospitalisation’.

Mild or moderate hypoglycaemia

If hypoglycaemia is suspected, the person should check their blood glucose. Treat if the blood glucose result is less than 4 mmol/L even when there are no symptoms. If the person is using a continuous subcutaneous insulin infusion (insulin pump), delivery of insulin can be suspended or if blood glucose is less than 2 mmol/L, the insulin pump can be disconnected.

Step 1 Have a quick acting carbohydrate exchange such as:

- > 100mls Lucozade
- > 5-6 jelly beans OR
- > 150mls soft drink (not diet).

The blood glucose is to be re-tested in 10 minutes, if blood glucose is still below target, step 1 is to be repeated. Step 1 can be repeated three times, however, if the blood glucose remains low, seek medical advice immediately.

Step 2 When in target, have a long acting carbohydrate exchange such as:

- > a slice of bread or toast OR
- > a glass (250mls) of milk OR
- > 1 piece of fruit OR
- > biscuits (eg 2 semi sweet biscuits, tiny teddy snack pack) OR
- > your usual meal (with adequate carbohydrate).

If the person is using a continuous subcutaneous insulin infusion (insulin pump), delivery of insulin can be recommenced. Avoid suspending insulin delivery or disconnecting the insulin pump for more than 1 hour.

Step 3

Measure the blood glucose more often (eg until peak insulin action has passed)

Consider the cause and talk to a credentialled diabetes educator or doctor. Adjustment of insulin/diabetes medication may be required to reduce risk.

Severe hypoglycaemia

Glucagon (GlucaGen®)

Glucagon is used to treat severe hypoglycaemia whereby a person is unable to swallow safely.

Glucagon is a hormone that increases glucose levels in the blood. It does this by releasing glucose (stored as glycogen in the liver) into the blood. This means that glucagon will only work to increase blood glucose if there are stores of glycogen in the liver.

All individuals who are at significant risk of severe hypoglycaemia (eg past history of severe hypoglycaemia or hypoglycaemia unaware/impaired) should be assessed for the appropriateness of teaching family/friend/carer in the administration of glucagon.

A doctor or nurse practitioner will need to prescribe a GlucaGen Hypo kit (Figure 1) for use by the person's family/friend/carer and they will require instruction.⁵

All ambulance officers are trained in the use of and carry GlucaGen Hypo kits. In CHSA, SA Ambulance Service (SAAS) Volunteers can administer glucagon in consultation with the SAAS Emergency Operations Centre Clinicians over the phone. Paramedics can administer intravenous glucose as first line treatment for hypoglycaemia but also carry glucagon in the event IV cannulation is unsuccessful.

Figure 1: Novo Nordisk GlucaGen® Hypo Kit®



Advice for non-medical person: inject the dose of glucagon into the fatty tissue just below the skin of the thigh or buttocks.

- > GlucaGen Hypo kit should be stored at room temperature (eg less than 25°C). Avoid freezing to prevent damage to the glass syringe. Protect powder vial from light.
- > The expiry date ('Expiry') is printed on the pack. If passed this date, do not use it. Check the expiry date from time to time to make sure that the glucagon in the GlucaGen Hypo kit has not expired. Expired kits are an excellent educational tool which allows partners/carers to practice a skill and gain confidence in their ability to help when the situation requires them to.
- > The glucagon solution should be injected immediately after it is prepared. It should not be stored for later use.
- > Adults and children above 25kg: inject full dose (marked on hypo kit syringe as 1/1mL).
- > Children under 25kg: inject half the full dose (marked on the hypo kit syringe as ½/1mL).

- > The person will normally respond within 10-15 minutes to the injection of glucagon.
- > Once conscious and safe to swallow, provide oral hypoglycaemia treatment as identified in Step 2.
- > People often have a distressing headache after a severe hypo and they may need to sleep once the blood glucose level is stabilised and in a safe range.
- > Adverse effects may also include nausea and/or vomiting.
- > After severe hypoglycaemia the liver stores of glucose are depleted, inform the person that they are at an increased risk of further episodes. It is important that adequate carbohydrate foods are consumed so that liver stores can be replenished.

For further information, refer to the [Australian Medical Handbook - Glucagon](#).⁶

Ongoing assessment

The person should be aware that hypoglycaemia can reoccur and that increased testing for the next 24 hours may be needed. This will depend on the severity and duration of episode.

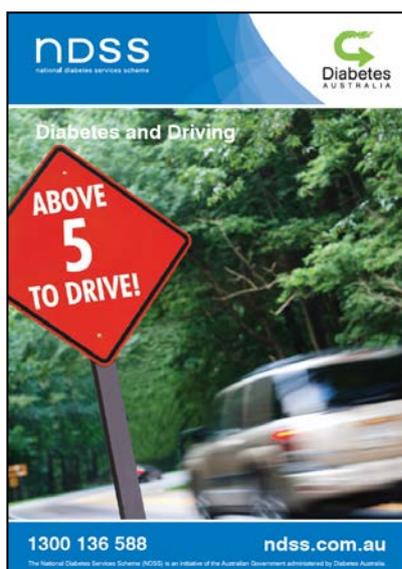
The person should also be encouraged to determine the cause of the hypoglycaemia and seek advice from their credentialed diabetes educator or general practitioner/specialist physician/endocrinologist. The next dose of medication may need to be modified and/or dose prior.^{7,8}

Diabetes and driving

Diabetes may affect a person's ability to drive either through a severe hypoglycaemic event or end organ damage that affects the person's vision, heart, nerves or feet. People with type 2 diabetes are also at a higher risk of sleep apnoea.⁹

The [AUS Roads Assessing Fitness to Drive](#)⁹ guidelines provides the medical standards for people wishing to obtain or maintain a private or commercial license. The National Diabetes Services Scheme (NDSS) offer two resources to assist health care professionals who are discussing diabetes and driving with their clients.

1. [Diabetes and Driving - Above 5 to drive](#)
2. [Driving and recent severe hypoglycaemia](#)



Prevention of hypoglycaemia

Educating people at risk of hypoglycaemia regarding the signs, symptoms, causes and early treatment of hypoglycaemia is the mainstay of prevention.

People with diabetes should be instructed to carry some form of quick acting and long acting carbohydrate at all times. Educate people at risk to carry an identification card or wear a medic alert bracelet.

Advise people to check their blood glucose or institute treatment at the first indication of possible hypoglycaemia.

If hypoglycaemia occurs frequently, this should be discussed with the general practitioner/specialist physician/endocrinologist so that their treatment plan is assessed and medication adjustment is discussed.

Family members and close friends can also be informed about the risk of hypoglycaemia and training provided to them regarding when and how to measure blood glucose and the use of glucagon injection if appropriate.

Educate people with diabetes who are at risk of hypoglycaemia to employ special care (eg increased monitoring, overnight glucose checks) when dietary intake and physical activity patterns are altered.

Developing a 'hypo' action plan

Credentialed diabetes educators/diabetes educators have an important role in assisting people to develop an individualised hypoglycaemia action plan.

A hypo kit is central to this action plan and the person should be asked to identify what foods would be most appropriate to keep in their 'hypo kit'.

Example of personalised 'hypo plans'.

Type 1 diabetes

My hypo action plan	
Contact details	Family / Friend: <i>Madeleine Olson</i> Doctor: <i>Dr. Janelle Winter, RSC</i> Credentialed diabetes educator: <i>Nicola Flavel</i> Health Direct (24hr health advice line) Phone: 1800 022 222
BG target	Treat if BGL less than <i>4.0</i> mmol/L even when there are no symptoms. Higher individual target: <i>4.5mmol/L / 5mmol/L</i> (for impaired awareness of low blood glucose / elderly / CVD). Ensure blood glucose is above 5mmol/L before driving.
Step 1	At home: <i>6 Jelly beans (in bag)</i> Out / car: <i>6 Jelly beans (in glove box)</i>
Step 2	Monitor BG – 10-15 minutes and repeat Step 1 until BG over 4mmol/L OR —
Step 3	Once blood glucose is above <i>4.1</i> mmol/L treat with At home: <i>250 ml of Milk</i> Out / car: <i>4 Water crackers (in glove box)</i>
Step 4	Monitor BG 2hrly until sure the risk of repeat hypo is gone OR —
Other issues to consider	Ambulance: If unconscious or unable to swallow. Do not give anything by mouth. Place on side on floor, ensure clear airway. Phone ambulance. Glucagon (if trained person available): <i>Mike Olsen (husband)</i> Medic Alert: <i>Planning to organize hypo</i> When to call doctor: <i>if hypo cause unknown</i> Driving (vehicle or equipment) > Discuss notification of Registrar of Motor Vehicles: <i>14/10/14</i> > Diabetes & Driving booklet given: <i>14/10/14</i> > Exercise: <i>Discontinued ADO/APAC TIGAR Quadriceps</i>
When to contact doctor or credentialed diabetes educator	1. If you have a severe hypo (you need help from someone). 2. If you have <i>3</i> mild hypos in a week.
Date: <i>14/10/2014</i>	Name: <i>Nicola Flavel</i> Signature: _____
<small>For more information CHSA Diabetes Service Country Health SA LHM PO Box 287, Rundle Mall ADELAIDE SA 5000 Telephone: (08) 8226 7168 www.diabetesouthsa.gov.au</small>	

Type 2 diabetes

My hypo action plan	
Contact details	Family / Friend: <i>Amanda Marden</i> Doctor: <i>Dr Paul Williams, CHCC</i> Credentialed diabetes educator: <i>Jane Rimmer</i> Health Direct (24hr health advice line) Phone: 1800 022 222
BG target	Treat if BGL less than <i>4.0</i> mmol/L even when there are no symptoms. Higher individual target: <i>4.5mmol/L / 5mmol/L</i> (for impaired awareness of low blood glucose / elderly / CVD). Ensure blood glucose is above 5mmol/L before driving.
Step 1	At home: <i>150ml of Lemonade (not diet).</i> Out / car: <i>6 Jelly beans.</i>
Step 2	Monitor BG – 10-15 minutes and repeat Step 1 until BG over 4mmol/L OR —
Step 3	Once blood glucose is above <i>4.1</i> mmol/L treat with At home: <i>1 piece of fruit or meal</i> Out / car: <i>6 Jatz biscuits</i>
Step 4	Monitor BG 2hrly until sure the risk of repeat hypo is gone OR —
Other issues to consider	Ambulance: If unconscious or unable to swallow. Do not give anything by mouth. Place on side on floor, ensure clear airway. Phone ambulance. Glucagon (if trained person available): <i>lives done n/a</i> Medic Alert: <i>Worn at all times</i> When to call doctor: <i>If cause of hypo unknown</i> Driving (vehicle or equipment) <i>Does not drive</i> > Discuss notification of Registrar of Motor Vehicles: <i>n/a</i> > Diabetes & Driving booklet given: <i>n/a</i> > Exercise: <i>BGM before, during and after. Aneta CHO prior or a reduction in your CHO needed.</i>
When to contact doctor or credentialed diabetes educator	1. If you have a severe hypo (you need help from someone). 2. If you have <i>3</i> mild hypos in a week.
Date: <i>8/10/14</i>	Name: <i>J Rimmer</i> Signature: _____
<small>For more information CHSA Diabetes Service Country Health SA LHM PO Box 287, Rundle Mall ADELAIDE SA 5000 Telephone: (08) 8226 7168 www.diabetesouthsa.gov.au</small>	

Hyperglycaemia

Definition of hyperglycaemia

Hyperglycaemia is defined as a fasting blood glucose concentration of greater than 7.0 mmol/L and post prandial concentration of greater than 11.1 mmol/L.¹⁰ However, symptoms are more commonly evident when the blood glucose concentration is greater than 15 mmol/L.

Primary causes

- > Insufficient insulin, omitting the insulin injection.
- > Insufficient oral hypoglycaemic agents or omitting to take medications as prescribed.
- > Excessive carbohydrate intake.
- > Stress.
- > Infection and illnesses eg exacerbation of respiratory conditions, gastroenteritis, myocardial infarction, urinary tract infection, wound infection, cellulitis surgery.
- > Medications eg steroids such as Prednisolone, Sodium Glucose Transporter 2 (SGLT2) Inhibitors.

Advanced hyperglycaemia

If the symptoms of hyperglycaemia are not recognised and treated early, the hyperglycaemia can become advanced and may ultimately lead to two types of diabetic emergencies, known as diabetic ketoacidosis and hyperglycaemic hyperosmolar state.

Diabetic ketoacidosis – type 1 diabetes

Prior to the discovery of insulin, the DKA mortality rate was 100%. Over the past 30 years, in developed countries, the mortality rate has reduced to approximately 2-5%.¹¹ However, DKA is the leading cause of diabetes related deaths in children and adolescents and foetal mortality rate remains high at approximately 30%.⁴ DKA must be diagnosed promptly and managed intensively.

Factors that increase the risk of DKA at the initial presentation of type 1 diabetes include:

- > young age eg under 5 years of age and especially under 2 years
- > low socioeconomic status
- > ethnic minority
- > delayed diagnosis
- > lower body mass index.

In established type 1 diabetes, those at an increased risk for DKA include:

- > poor glycaemic control eg above target HbA1c and higher reported insulin requirements
- > gastroenteritis with vomiting and dehydration
- > peripubertal and pubertal adolescent girls
- > history of psychiatric disorders including eating disorders
- > unstable family circumstances
- > inadvertent or intentional omission of insulin, including failure of an insulin pump
- > use an insulin pump (this is because insulin pumps only use rapid acting insulin and so insulin deficiency can occur very quickly)
- > are pregnant
- > have multiple co-morbidities which may include end-stage organ failure

- > are elderly
- > live in a remote/isolated area some distance from medical support.¹⁰

Given that most cases of DKA occur in people with known diabetes it is believed to be largely preventable by:

- > frequent monitoring of blood glucose levels
- > early detection of ketosis and adequate replacement of insulin
- > patient education and support
- > health care professional awareness and education
- > access to medical advice (eg 24 hour telephone, home visits, out patients service).

Pathophysiology

DKA consists of the biochemical triad of hyperglycaemia, ketonaemia and acidaemia.¹⁰ It results from the absence of insulin. Although small amounts of circulating insulin may be present, the presence of large amounts of the counter regulatory hormones such as glucagon, adrenaline and noradrenaline and cortisol, result in the insulin being less effective.

The combination of low insulin and high counter-regulatory hormone concentrations causes an accelerated catabolic state, with increased glucose production by the liver and kidneys and impaired peripheral use.

If the metabolic disturbances are not appropriately corrected with exogenous insulin and fluid and electrolyte therapy, severe dehydration and metabolic acidosis will occur.

The goals of management are to treat the underlying cause and to safely

- > replace fluid and electrolyte losses
- > administer insulin and reduce ketone production
- > normalise blood glucose.

Features of DKA

The signs of DKA are hyperglycaemia, glycosuria, ketosis, dehydration and electrolyte imbalance.

Glycosuria: occurs as the concentration of glucose in the blood exceeds the renal threshold (ie capacity to reabsorb).

Polyuria: glucose in the urine acts as an osmotic diuretic, which can lead to dehydration if left untreated.

Polydipsia: thirst will occur as the body attempts to replace the lost fluid.

Ketosis: as fats are broken down to supply energy, ketoacids accumulate in the blood stream causing ketosis and acidosis. Due to the lack of insulin, the ketoacids are not able to be cleared. Ketosis can also be recognised by an acetone breath. The accumulation of ketones in the blood and excretion of ketones in the urine (ketonuria) leads to more electrolyte imbalance and dehydration.

Gastrointestinal: symptoms are nausea, vomiting, and abdominal pain.

Respiratory: symptoms may include hyperpnoea (increased ventilation) and/or deep rapid breathing (Kussmaul's respirations) which produces a respiratory alkalosis as the body attempts to correct the metabolic acidosis.

Polyuria, ketonuria and acidosis cause loss of body potassium. However, acidosis causes potassium to move from the cells to the plasma. Hence, the circulating potassium may be low, normal or high.

If acidosis and hyperglycaemia continue, they may lead to **coma** and **death**.

The diagnosis of DKA is commonly determined by a triad of blood ketones, blood glucose and bicarbonate.

blood ketones ≥ 3 mmol/l or urine ketones $\geq 2+$ on dipsticks
blood glucose ≥ 11 mmol/l
bicarbonate (HCO_3^-) <15 mmol/l and/or venous pH <7.3

However, DKA can occur if the blood glucose is less than 11 mmol/L.

For further information on the inpatient management of DKA, refer to CHSA '*Diabetic Ketoacidosis*' Protocol.

Prevention

It is important that the person understands that DKA is commonly caused by concurrent infection and insulin omission. Illness associated with fever and/or inflammation raise blood glucose. Illness associated with vomiting and diarrhoea lower blood glucose.

Equipping the person with clear guidance for managing sick days will reduce the risk of developing DKA. Every person no matter what type of diabetes they have or what the treatment is needs to have an individualised sick day action plan.

Ketone testing

Ketone monitoring is indicated when the person with type 1 diabetes is unwell or the BGL is greater than 15 mmol/L. It is used to avoid DKA by detecting insulin deficiency and guiding insulin replacement. Ketones can be measured in 2 ways:

1. Beta-hydroxybutyrate (β -OHB) in capillary blood.
2. Acetoacetic acid in urine.

Evidence shows that measuring blood ketones is a more sensitive test for detecting ketosis as compared with urine ketones. The NHMRC guidelines therefore recommend that blood ketone measurement should be taught as part of a comprehensive sick day management plan. However, if blood ketone strips are not available urine ketone measurement is the alternative test.

Correctional Insulin

Correctional, also known as **supplemental**, insulin doses of rapid acting insulin may be administered to manage hyperglycaemia and ketosis.

A correctional insulin dose should be:

1. Calculated as a percentage of the usual total daily dose (TDD).
2. Given **in addition** to the usual prescribed basal and meal related insulin doses.

Correctional insulin doses can be given 2-4 hourly. Medical care should be sought if there is no improvement (or indeed if there is deterioration) in blood glucose or ketones after 2 correctional doses have been given.^{5,9}

Continuous Subcutaneous Insulin Infusion

People using continuous subcutaneous insulin infusion, also known as insulin pump therapy, can develop ketosis and DKA more quickly than those patients using multiple daily subcutaneous injections as there is no background long acting insulin used.

The insulin pump basal rate and/or correctional boluses may need to be increased during the period of illness. If a patient is unwell and the blood glucose is greater than 15 mmol/L or above the following steps should be taken:

- > check for problems with the pump, line and connections and change the cannula, tubing and reservoir if required
- > check for ketones in blood/urine. If ketones are positive OR hyperglycaemia cannot be corrected, suspect a problem with the pump.

The emergency plan should include a subcutaneous insulin regimen and information on calculation of insulin doses should there be an urgent need to switch from insulin pump therapy back to basal bolus insulin.

Sick day management principles in type 1 diabetes

A comprehensive guide to [Sick day management in type 1 diabetes](#)¹² has been developed by the Australian Diabetes Educators Association.

These guidelines apply when the person with type 1 diabetes:

- > is feeling unwell or notices signs of an illness
- > notices ketones in blood (greater than or equal to 0.6 mmol/L) or urine (small)
- > has blood glucose greater than target.

For further information, refer to the CHSA factsheets - '*High blood glucose in type 1 diabetes (hyperglycaemia)*' for an individualised Sick Day Action Plan.

Key points

1. Sick day management education must be provided soon after initial diagnosis as an integral part of survival skills information for people with type 1 diabetes.
2. More frequent blood glucose monitoring is needed during episodes of illness.
3. Blood ketone levels should be measured during times of illness, even if blood glucose is not high. Blood ketones may occur in the setting of low/'normal' blood glucose levels in the presence of poor oral intake. Blood ketone monitoring is the preferred method of measuring ketosis.
4. People with type 1 diabetes should be reminded to never discontinue taking their insulin, especially basal insulin.
5. Pre meal short/rapid acting insulin may need to be reduced if dietary carbohydrate intake is poor and blood glucose levels are not elevated.
6. Correctional doses of rapid-acting insulin should be administered according to sick day management plan and medical officer instructions.
7. DKA is a life-threatening condition in people with type 1 diabetes.
8. A sick day management plan should be tailored to the individual needs of the person with diabetes and be initiated at the first signs of illness.
9. For people using continuous subcutaneous insulin infusion, the sick day plan should include a subcutaneous insulin regimen and/or education on calculation of insulin doses should there be an urgent need to switch from insulin pump therapy back to multiple daily injections.
10. Investigate and manage the underlying illness.
11. Discontinue home management of sick days if situation deteriorates, if the person fails to respond to increased insulin.

Hyperglycaemic hyperosmolar state (HHS) – type 2 diabetes

Hyperglycaemic hyperosmolar state (HHS) is a medical emergency which must be diagnosed promptly and managed intensively. HHS has a significant mortality rate of approximately 20%.¹¹ HHS is different to DKA and as such requires a different approach. HHS typically occurs in the older person however, with type 2 diabetes being diagnosed at younger ages it may be seen in young adults or teenagers.^{10, 13} Whilst DKA can develop over a few hours to days, HHS often develops over days to weeks. Consequently the dehydration and metabolic disturbances can be more extreme.

Predisposing factors that increase the risk of HHS at the initial presentation of type 2 diabetes include:

- > infection eg pneumonia, urinary tract infection, sepsis
- > cerebral vascular accident
- > myocardial infarction
- > pancreatitis
- > pulmonary embolism
- > total parental nutrition
- > intestinal obstruction
- > peritoneal dialysis, renal failure
- > heat stroke, severe burns
- > hypothermia
- > endocrine disorders eg acromegaly, thyrotoxicosis, cushing's syndrome
- > medications eg beta-adrenergic and calcium channel blockers, immunosuppressive agents, phenytoin, propranolol, steroids, thiazide diuretics.¹⁰

In established type 2 diabetes, people are at an increased risk for HHS include the acute illnesses, endocrine disorders and medications as above, but also those whom have inadequate oral hypoglycaemic agents and/or injectables.⁷

Pathophysiology

The basic underlying pathophysiology is similar to that of DKA whereby there is a reduction in the net effective concentration of circulating insulin coupled with an elevation of counter-regulatory stress hormones. It is important to be aware that there can be a mixed picture of HHS and DKA.

In HHS, there is a residual amount of insulin secretion that minimises ketosis (less than 3 mmol/L). However, this endogenous insulin is not enough to control hyperglycaemia and leads to severe dehydration, impaired renal function and decreased excretion of glucose. It is the dehydration and renal crisis that causes more severe hyperglycaemia than is seen in DKA.

Features of HHS

If the person is unable to replace fluids, dehydration and mental impairment occurs. This is especially likely in the elderly. Hence this acute complication often occurs in the elderly on oral hypoglycaemic agents who may be inadequately monitored or not receiving adequate fluid intake and unable to communicate their needs.

The high plasma osmolality and dehydration lead to:

- > decreased skin turgor
- > hypotension
- > elevated body temperature
- > drowsiness

- > confusion
- > convulsions
- > coma.¹³

The diagnosis of HHS is determined by:

marked hyperglycaemia >30 mmol/L without significant ketones (<3.0mmol/L) or acidosis (pH <7.3, bicarbonate <15 mmol/L (<3.0 mmol/L)
hypovolaemia
osmolality >320 mosmol/Kg

For further information on the inpatient management of HHS, refer to CHSA Protocol - '*Hyperglycaemic hyperosmolar state management in adults with type 2 diabetes*'.

Prevention

To prevent HHS from occurring, identify those at high risk and ensure the older person is well hydrated.

All people with type 2 diabetes require a sick day action plan and information on when to seek medical advice.

Sick day management principles in type 2

A comprehensive guide to [Sick day management in type 2 diabetes](#)¹² has been developed by the Australian Diabetes Educators Association .

These apply when the person with type 2 diabetes

- > is feeling unwell or notices signs of an illness
- > has blood glucose greater than 15 mmol/L for more than 8-12 hours.

For further information, refer to the CHSA factsheet - '*High blood glucose in type 2 diabetes (hyperglycaemia)*' for an individualised Sick Day Action Plan and as required the CHSA factsheet - '*SGLT2 Inhibitors - medication for type 2 diabetes*'.

Key points

1. A sick day management plan should be tailored to the individual needs of the person with diabetes and be initiated when the first signs of illness occur.
2. People with diabetes should be reminded to never discontinue taking their insulin or glucose lowering medicines unless otherwise advised by their diabetes specialist team.
3. Assistance from the individual's doctor or diabetes team should be sought early in a period of illness as prompt medical assistance may be required to advise the patient on appropriate adjustment of oral and/or injectable diabetes medications.
4. As many people with insulin treated type 2 diabetes are prescribed basal or premixed insulin, they do not have access to rapid-acting insulin to use as a correctional insulin dose, therefore medical assistance must be sought in the early stages of illness in these patients to facilitate access to appropriate insulin.
5. More frequent blood glucose monitoring is recommended during episodes of illness.

6. Blood ketone monitoring may be recommended during episodes of illness if at risk of DKA. Whilst DKA is considered uncommon in individuals with type 2 diabetes, it may occur in people with type 2 diabetes who are insulin deficient, lean, pregnant women, prescribed a sodium glucose co-transporter 2 inhibitor (SGLT2) or known to have previously shown ketones.

For further information, refer to the CHSA factsheet - '*SGLT2 Inhibitors - medication for type 2 diabetes*'.

7. The presence of co-morbidities and/or end-stage organ failure will require the person to seek prompt medical attention regardless of blood glucose levels.

8. People with renal impairment should be advised to cease metformin promptly if an intercurrent illness is leading to dehydration.

9. Investigate and manage the underlying illness.

10. Discontinue home management of sick days if situation deteriorates, if the person fails to respond to increased insulin.

Recommended Sick Day Management Kit

People with diabetes should be advised to check their kit at least every 6 months to ensure the kit is fully stocked and the following items:

- Copy of the sick day guidelines.
- Telephone numbers to call eg support people, general practitioner, local hospital and/or diabetes clinic, diabetes educator, endocrinologist.
- Food and fluid for sick days (sweet and unsweetened).
- Pain relief such as paracetamol or ibuprofen.
- Rapid-acting insulin (if prescribed).
- Insulin syringes or insulin pen (if prescribed/recommended by medical team).
- In-date blood glucose monitoring strips.
- Glucagon (in those with type 1 diabetes and if recommended by medical team).

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