



Association of Children's Diabetes Clinicians



Clinical Guideline

Management of Type 1 Diabetes Mellitus during illness in children and young people under 18 years (Sick Day Rules)

SETTING

FOR STAFF

Medical and nursing staff

PATIENTS

Children and young people with diabetes mellitus

Version History:

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Patient group

This guideline is intended for use in managing illness and high blood glucose levels for all children and young people up to the age of 18 years with diabetes mellitus.

Introduction

Illness generally causes a rise in the blood glucose levels and increases the risk of ketone body production due to a relative deficiency of insulin. An increase in counter-regulatory hormone production causes gluconeogenesis and impaired peripheral glucose uptake which in turn leads to hyperglycaemia and hyperosmolality. Insulin deficiency leads to lipolysis, hepatic fatty acid oxidation and formation of ketone bodies.(1) This can result in Diabetic Ketoacidosis (DKA) if adequate insulin and hydration is not maintained.

Increased stress hormone levels during illness contribute to elevated blood glucose. Cytokine release in response to infection can also lead to some degree of insulin resistance.(2)

Diarrhoea and vomiting may reduce blood glucose levels, increasing the risk of hypoglycaemia rather than hyperglycaemia. Ketones may still be produced in significant quantities even with hypoglycaemia in gastroenteritis(3, 4).

Importance of Local 'Sick-Day' Rules

NICE guidelines recommend that children and young people with T1DM should be offered clear guidance for the management of diabetes during periods of illness(5). Adequate sick day management at home may reduce the risk of progression to DKA and admission to hospital.(6) The use of sick-day rules which include self-monitoring of blood glucose and ketones, and timely administration of supplemental insulin and fluids leads to reduced hospitalisation and potential cost savings.(7) DKA admissions are associated with increasing age, high HBA1c, high insulin doses and female sex.(8, 9)

1. Ketone testing

Ketones are produced from the liver when there is a lack of glucose (starvation ketones) and as an alternative energy source when there is a relative insulin deficiency.

Ketone bodies consist of beta-hydroxybutyrate, acetoacetate and acetone. In a physiological state beta-hydroxybutyrate and acetoacetate are present in the body in a 1:1 ratio but in DKA the ratio can be as high as 10:1. In response to insulin, beta-hydroxybutyrate levels fall faster than acetoacetate levels (10). A blood beta-hydroxybutyrate level > 0.5mmol/l is abnormal in children with diabetes.(11)



Urine ketone stick testing detects only acetoacetate and not beta-hydroxybutyrate(12). The test is inconvenient, is not the best indicator of ketone body levels and provides only a semi quantitative assessment and is associated with false-positive results. Also, urine ketones may remain positive long after DKA has resolved giving the impression that DKA is not responding to treatment. This is because as DKA improves, there is a net conversion from beta-hydroxybutyrate to acetoacetate which is then excreted in urine. (1, 10)

A recent systematic review has shown that blood ketone testing is superior to urine ketone testing for the prevention and management of DKA.(13) Near-patient capillary beta-hydroxybutyrate meters correlate well with superior laboratory methods but have limited precision and accuracy above 3mmol/l.(14) Capillary beta-hydroxybutyrate correlates with other biochemical markers of DKA(15-18) and is more sensitive than urine testing in reflecting patient's metabolic state before and during treatment.(19) Furthermore, patients are less likely to test their urine than their blood, and a randomised study of blood and urine testing showed a reduction in hospitalisation, which led to cost savings, when blood testing was carried out at home during illness.(20)

In children using insulin pumps, who are at high risk of developing DKA during pump malfunctions, capillary ketone testing led to earlier detection of ketosis following pump interruption, allowing for preventative action to be taken.(21)

Recommendations –

- We recommend the use of blood ketone testing instead of urine ketone testing during illness⁴.
- All CYP and their families and carers should be provided with equipment to measure blood ketone levels during illness

2. Fluid Management

There is evidence that children and adolescents admitted to hospital with DKA are dehydrated, this is due to a combination of polyuria and vomiting.(22, 23)

During intercurrent illness, the main reason for ensuring adequate hydration is to promote renal excretion of ketone bodies. There is no evidence to support any specific drink/liquid. Water or other sugar-free drinks are probably most appropriate in most cases where blood glucose is high. Drinks with higher concentrations of glucose (fast-acting carbohydrate fluids: fruit juice, regular (non-diet) soft drink, glucose solutions) are appropriate where blood glucose is low or normal and starvation ketones are thought to be prominent. If nausea limits volume, small frequent sips should be encouraged.

When ketosis is present, hydration is a cornerstone of treatment to avoid water and electrolyte deficits that may progress to acidosis and DKA. Frequent small sips of water and/or electrolyte-containing liquids should be given every 5–10 minutes. Suggested approximate volume of fluids may be either 4–6 ml/kg/hr or 100 ml/hr.



Carbonation slows absorption from the stomach but recommendations suggest they may be considered if shaken or stirred to reduce carbonation(24).

Recommendations –

- Advise patients to monitor fluid intake and ensure they are drinking adequate fluid volumes to keep well-hydrated
- Once vomiting with high ketones, have a low threshold for admission to hospital

3. Out of hours diabetes advice

There is evidence to suggest that access to 24 hour advice on diabetes care can reduce admissions and length of stay for children and young people in DKA with established diabetes. An Italian study showed that the introduction of a toll free 24 hour hotline managed by staff with some experience in diabetes helped to avoid hospital admissions during sickness(25). This can be effective when delivered by paediatric diabetes specialist nurses (PDSNs) as well as non-diabetes team staff provided there is training for staff responding to emergency calls and agreed guidelines in place(26).

Recommendations –

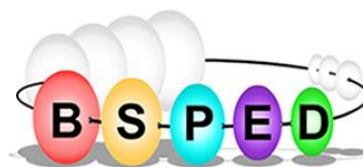
- All CYP and families should be offered access to 24hr telephone advice. This may be delivered by either members of the diabetes team or other trained healthcare professionals working to an agreed protocol
- Where the initial advice **is being given by** healthcare professionals who are not members of the diabetes team, there needs to be a process in place for ensuring the diabetes team are made aware of any out-of-hours contact
- The out of hours service should be regularly reviewed and audited

4. Diabetes Self Management Education

Diabetes self-management is the process of providing CYP with the diabetes education, knowledge and skills needed to successfully manage their diabetes. (27) Children with better self management have reduced rates of DKA(28)

Recommendations -

All CYP and their families and carers should be taught what to do when ill (sick day rules) at diagnosis, annually, at transition and opportunistically. This can be done either in 1:1 or group sessions



- All CYP and their families and carers should have written information about
 - what to do when ill
 - how to test blood ketones and interpret results
 - when to seek advice from their diabetes team and important contact numbers/addresses of health care team

5. General Rules for Managing Diabetes During Illness

There are no clinical trials on fluids, frequency of blood glucose monitoring and insulin doses during illness. However, various national and international recommendations (ISPAD(4), ADA(29), APEG(30)) about the management of illness in children with diabetes are currently used. These recommendations are based on consensus and good practice. Practice in the UK is variable and there is no national consensus guideline on managing illness in children with Type 1 diabetes. ACDC has developed this guideline based on the best evidence available.

Recommendations -

- Never stop or omit insulin.
 - However, doses may need to be reduced or increased and this will depend on blood glucose and ketone levels.
- Check blood glucose more frequently e.g every 2 hours including through the night. When CYP are using CGM, capillary glucose check should still be performed. Hypoperfusion and dehydration can reduce the accuracy of these devices.
 - This will help distinguish between conditions associated with hyperglycaemia and hypoglycaemia
- Check for blood ketone levels whenever a child is ill, regardless of blood glucose level
 - *Rarely, ketone levels may be elevated even if BG levels are normal, for example in gastroenteritis*
- Give additional fast acting insulin every 2 hours if blood glucose is above target. **(See Table 1)**

Several methods for calculating increased doses of insulin are practised around the world. A National survey in 2015, found that a percentage increase in insulin based on total daily dose was the commonest method used in the UK (31). This guideline has recommended the most frequently used methods, but services should make sure that their local guidelines are clear, and they train CYP and families in managing their sick days based on the locally agreed method.

- If ketones are less than 0.6mmol/l, then give the usual correction insulin dose

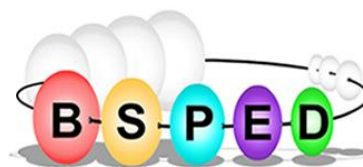


- If ketones are between 0.6mmol/l and 1.5mmol/l then advise that patient has 10% of the total daily dose of insulin (TDD), or 0.1 units/kg body weight, as additional fast acting insulin
 - If ketones are >1.5mmol/l then advise that patient has 20% of TDD, or 0.2 units/kg body weight as additional fast acting insulin
 - ISPAD guideline also suggests a calculation of insulin dose as a percentage increase in the correction dose based on the correction factor/insulin sensitivity factor. It suggests a 10% increase in mild ketosis and 20% increase in moderate/severe ketosis. If ketosis doesn't improve, further increases up to 150-200% of the correction dose can be made. For adolescents, on an aggressive correction factor, a % increase in their correction factor might be more suitable than other suggested methods.
- If ketones are present when blood glucose is low (usually less than 4mmol/L), they are called 'starvation ketones' and respond to drinking extra fluids containing sugar. Monitor blood glucose very closely as extra insulin may be required when blood glucose starts rising.
 - Keep well hydrated by drinking plenty of fluids.
 - Water or sugar-free fluids are probably most appropriate in the majority of cases where blood glucose levels are high
 - If blood glucose levels are low or normal, drinks containing glucose are required, or take oral carbohydrates if possible
 - Avoid carbonated drinks if possible.
 - Inform the diabetes team early to seek advice
 - Treat the underlying condition



TABLE 1

Negative ketones <0.6mmol/l (Blood)	Small to moderate ketones 0.6 – 1.5mmol/l (Blood)	Moderate to large ketones >1.5mmol/l (Blood)
Take a correction dose (CD) to correct high blood glucose (BG) in addition to normal bolus for carbohydrates eaten	Give 10% of your total daily dose (TDD) of insulin as additional fast acting insulin OR - units/kg body weight as additional fast acting insulin OR - Increase correction dose by 50%	Give 20% of your total daily dose (TDD) of insulin as additional fast acting insulin. OR 0.2 units/kg body weight as additional fast acting insulin OR - Increase correction dose by 100%
Then: Re-check BG and ketones in two hours	Then: - Monitor fluid intake and ensure you are drinking enough fluids to keep well-hydrated - Re-check BG and ketones in two hours (See below)	Then: - Monitor fluid intake and ensure you are drinking enough fluids to keep well-hydrated - Re-check BG & ketones in two hours (see below)
If your BG is going down that is a good sign but monitor closely throughout the day. If BG is increasing but ketones less than 0.6mmol/l: Take another correction dose using a pen If ketones 0.5 – 1.5mmol/l, follow orange column advice If ketones >1.5mmol/l, follow the red column advice	If ketones negative follow green column advice If BG is increasing but ketones still 0.6 – 1.5mmol/l: - Continue to give 10% of TDD or 0.1 Units/kg as additional fast acting insulin every 2 hours using a pen or Increase correction dose by 50% - Give usual boluses for food - Re-check BG and ketones every 2 hours even through the night! If ketones increase to >1.5mmol/l, follow the red column advice	If ketones negative follow green column advice If BG is increasing but ketones have reduced to 0.6 – 1.5mmol/l, follow orange column advice If ketones are still >1.5mmol/l: - Give another 20% TDD or 0.2units/kg as additional fast acting insulin every 2 hours using a pen or increase correction dose by 100% - Give usual boluses for food - Once vomiting with high ketones, have a low threshold for admission to hospital



5.1. Using sick day doses on pump therapy

The same principles of illness management apply to patients on insulin pumps. Even when unwell, if blood glucose levels are high, standard checks on the pump should be made for occlusions, disconnection, battery failures etc.

Only give correction doses through the pump if blood ketone levels are less than 0.6mmol/l. If blood ketones are higher than 0.6mmol/l, give additional fast acting insulin using an insulin pen. If one correction dose given via the pump has no effect in 1 hour, repeat the correction dose with an insulin pen. Monitor blood glucose regularly.

When blood glucose levels are rising in an unwell child needing frequent additional insulin doses, think about using higher temporary basal rates. Up to 200% of normal basal rates may be needed in some patients.

5.2 Using sick day doses on Hybrid closed loop therapy (HCL)

The basic principles are the same as managing sick day rules on non HCL pump therapy. Standard checks on pumps need to be carried out. Most HCL manufacturers advise coming out of auto- mode and running the pump in manual mode if ketones are > 0.6 mmol/l. Once the pump is in manual mode, sick day rules for pump therapy should be followed.

If ketones are <0.6 mmol/l, the child can still be managed on hybrid closed loop therapy. They will need regular blood glucose and ketone monitoring every 2 hours. If blood glucose is below target, and insulin is suspended, there is a risk of developing ketones.

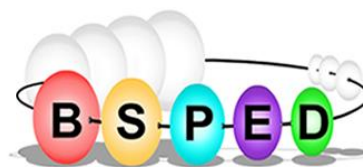
ACDC group has developed HCL training leaflets which have device specific advice (Appendix 2).

5.3 Management of infections usually associated with hypoglycaemia eg. Gastroenteritis

Nausea and vomiting should be considered as a sign of insulin deficiency until proven otherwise. Nausea and vomiting can be caused by illness itself. It is important to check blood glucose and ketones regularly (2 hourly) even if blood glucose is within normal range.

Ketones in association with hypoglycaemia indicate inadequate intake and this can be resolved by increasing carbohydrate intake

- Encourage regular small sips of sugar-containing drinks (NOT diet drinks) as tolerated, refer to local fluid challenge guidelines



- If not taking much orally and BG are in low range, DECREASE usual fast acting insulin by 20-50% (for those on pumps, consider reducing basal rate by 20-50% if in manual mode) whilst illness persists, however glucose must be closely watched to ensure the glucose and ketones do not then rise due to insulin deficiency.
- If BG are >10mmol/l but <14 mmol/l, give usual fast acting dose of insulin.
- If BG are >14mmol/l, check blood ketone levels, see above for extra insulin doses
- If vomiting with illness consider treatment with anti emetic medications
- Once oral intake is tolerated, give NORMAL doses of insulin
- If not tolerating anything orally and BG are <4mmol/l, advise attending hospital. If drowsy or reduced conscious level, advise IM glucagon as follows and dial 999:
 - a. If age under 12 give 0.5 mg glucagon by IM injection
 - b. If age 12 or over, give 1 mg glucagon by IM injection
- Or
- BNF guidance uses body weight
- 2-17 yrs body weight <25kg 0.5mg glucagon by IM injection
- 2-17y body weight >25kg for 1mg glucagon by IM injection
- If then able to tolerate oral intake and BG >4mmol/L, can go home. If not tolerating anything orally or BG still <4mmol/L, admit for observation and intravenous dextrose if necessary.
- If a child has HIGH glucose (>14mmol/L) , with ketones and is vomiting, this is DKA and they should be advised to attend hospital urgently.

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Appendix 1

Patient Advice leaflet

Patient Advice for Management of Type 1 Diabetes Mellitus during illness in children and young people under 18 years (Sick Day Rules)

Note to parents and patients: This guideline should be discussed with your Paediatric Diabetes team before you use it as in some cases they may have to adapt it for your individual use

Sickness is an unavoidable part of everyday life. The body's natural response to illness results in higher blood glucose levels due to the release of stress hormones. During illness, you will need frequent blood glucose monitoring and often more insulin than usual.

What are ketones?

Ketones are acids which can make you feel very sick. They are produced when the body is not getting enough food (glucose) or your body is not able to use glucose due to lack of insulin. If you do not get rid of ketones, you can become dehydrated and eventually develop Diabetic ketoacidosis. **Check for ketones whenever you are ill**, regardless of your glucose levels as you can have raised ketones with normal glucose levels i.e. starvation ketones with gastroenteritis.

Sick day rules

1. **Never stop the insulin.** Even if you are eating less than normal, your body needs insulin to use glucose and to get rid of ketones.
2. Check your blood glucoses more frequently eg every 2 hours including throughout the night.
3. Check for blood ketones. Give additional fast acting insulin every 2 hours if blood glucose is above target. **(See Table 1)**
4. If ketones are present when blood glucose is **low**, they are called 'starvation ketones' and respond to drinking extra fluids containing sugar. Monitor blood glucose very closely and extra insulin may be required when blood glucose starts rising.
5. Keep well hydrated by drinking plenty of fluids.
 - a. Water, or sugar-free fluids are probably most appropriate in the majority of cases where blood glucose levels are normal or high



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- b. If blood glucose levels are low, drinks containing sugar are required, or eat carbohydrates if possible.
- c. Avoid carbonated drinks if possible
6. Inform the diabetes team early to seek advice

Using Sick day rules for pump patients

1. Same principles apply for pump patients with regards to glucose testing and fluid intake.
2. In addition, even if unwell and blood glucose is high, standard checks on the pump should be made for occlusions, disconnection and battery failures.
3. Give correction doses through the pump if blood ketone levels are less than 0.6mmol/l. If one correction dose given via the pump has no effect in 1 hour, repeat the correction dose with an insulin pen.
4. If blood ketones are higher than 0.6mmol/l, give additional fast acting insulin using an insulin pen.
5. When blood glucose levels are rising in an unwell child needing frequent additional insulin doses, think about using higher temporary basal rates.

6.

Table1

Negative ketones <0.6mmol/l (Blood)	Small to moderate ketones 0.6 – 1.5mmol/l (Blood)	Moderate to large ketones >1.5mmol/l (Blood)
Take a correction dose (CD) to correct high blood glucose (BG) in addition to normal bolus for carbohydrates eaten	Give 10% of your total daily dose (TDD) of insulin as additional fast acting insulin - OR 0.1 units/kg body weight as additional fast acting insulin - OR - Increase correction dose by 50% .	Give 20% of your total daily dose (TDD) of insulin as additional fast acting insulin. - OR 0.2 units/kg body weight as additional fast acting insulin - OR - Increase correction dose by 100%
Then: Re-check BG and ketones in two hours	Then: - Monitor fluid intake and ensure you are drinking enough fluids to keep well-hydrated - Re-check BG and ketones in two hours (See below)	Then: - Monitor fluid intake and ensure you are drinking enough fluids to keep well-hydrated - Re-check BG & ketones in two hours (see below)
If your BG is going down that is a good sign but monitor closely throughout the day. If BG is increasing but ketones less than 0.6 mmol/l: Take another correction dose using a pen If ketones 0.5 – 1.5mmol/l, follow orange column advice If ketones >1.5mmol/l, follow the red column advice	If ketones negative follow green column advice If BG is increasing but ketones still 0.6 – 1.5mmol/l: - Continue to give 10% of TDD or 0.1 Units/kg as additional fast acting insulin every 2 hours using a pen - Give usual boluses for food - Re-check BG and ketones every 2 hours even through the night! If ketones increase to >1.5mmol/l, follow the red column advice	If ketones negative follow green column advice If BG is increasing but ketones have reduced to 0.6 – 1.5mmol/l, follow orange column advice If ketones are still >1.5mmol/l: - Give another 20% TDD or 0.2units/kg as additional fast acting insulin every 2 hours using a pen - Give usual boluses for food - Once vomiting with high ketones, go to Accident and Emergency



Appendix 2

Hybrid closed Loop and Sick day rules

From ACDC leaflets available at <https://www.a-c-d-c.org/endorsed-guidelines/>

General Principles

Check for ketones and monitor glucose more frequently

If ketones are 0.6 mmol/l, give a correction bolus of rapid acting insulin via an insulin pen

If glucose remains high, for 2 hours or more, change pod or cannula, insulin set and insulin cartridge

Call diabetes team for advice if unsure or not improving. Follow you local sick day rule guidance

Omnipod 5

Sick Day Rules

NOTE: Please also check local diabetes team guidance.

If an illness/unexplained hyperglycaemia is causing glucose levels to run higher than usual:

- Check for ketones and monitor glucose levels more closely
- Change the Pod if glucose remains high, for 2 hours or more
- If ketones are >0.6 mmol/L give a correction dose of rapid acting insulin using an insulin pen

NOTE: If unsure how to calculate this dose, contact the diabetes team

Further measures may include:

- To remain in Automated Mode during periods of high glucose levels/sickness, however, if switched off recommence Automated Mode once glucose levels and ketones are resolving (<0.6 mmol/L)
- Drinking sugar-free fluid as well as eating carbohydrates, with insulin boluses, little and often



Remember!

Always contact with the diabetes team in the event of high glucose levels and illness.

If unsure how much to drink or eat, always contact the local diabetes team.



T: slim X2

Sick Day Rules

NOTE: Please also check local diabetes team guidance.

If an illness/unexplained hyperglycaemia is causing glucose levels to run higher than usual:

- Check for ketones and monitor glucose levels more closely
- Change the infusion set/cannula and insulin cartridge if glucose remains high, for 2 hours or more
- If ketones are >0.6 mmol/L give a correction dose of rapid acting insulin using an insulin pen

NOTE: If unsure how to calculate this dose, contact the diabetes team.

There are 2 options for recording the insulin pen correction dose:

1. Enter the pen correction dose as a bolus into the pump (whilst it is disconnected from the body), to ensure the pump can include this in its active insulin going forward.
2. Switch Control-IQ technology off, administer a pen correction and remain on the pump in Manual Mode until glucose levels and ketones are resolving.

Drink sugar-free fluid as well as eating carbohydrates little and often giving insulin boluses.

Treatment options **according to local diabetes team advice:**

1. Remain in Control IQ during periods of high glucose levels/sickness.
2. If there is a Sick Day Profile pre-programmed within the pump, switch to this until the glucose and ketones are resolving (ketones <0.6 mmol/L).
3. If Control IQ is switched off, increase Temporary Basal Rate (as per local diabetes team advice) and recommence Control IQ once the glucose and ketones are resolving (ketones <0.6 mmol/L).



Remember!

Always contact with the diabetes team in the event of high glucose levels and illness.

If unsure how much to eat or drink, always contact the local diabetes team.

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Cam APS

Sick Day Rules

NOTE: Please also check local diabetes team guidance.

If an illness/unexplained hyperglycaemia is causing glucose levels to run higher than usual use the Boost function and:

- Check for ketones and monitor glucose levels more closely
- Change the infusion set/cannula and insulin cartridge if glucose remains high, for 2 hours or more
- If ketones are >0.6 mmol/L give a correction dose of rapid acting insulin using an insulin pen

NOTE: If unsure how to calculate this dose, contact the diabetes team

NOTE: If ketones are above 0.6 mmol/L, stop Auto Mode (closed loop) and follow sick day rules as per local guidelines

- Remain on the pump in Manual Mode until glucose levels and ketones are resolving (0.6 mmol/L or below)
- Enter the correction as a bolus into the pump (whilst disconnected from the body), to ensure the pump can include this dose in its Active Insulin going forward
- Consider using a Temp Basal Rate whilst in Manual Mode
- Drinking sugar-free fluid as well as eating carbohydrates, with insulin boluses, little and often



Remember!

Always contact the diabetes team in the event of high glucose levels and illness.

Recommence Auto Mode once glucose levels and ketones are resolving (0.6 mmol/L or below).

If unsure how much to eat or drink, always contact the local diabetes team.



MiniMed 780G

Sick Day Rules

NOTE: Please also check local diabetes team guidance.

If an illness/unexplained hyperglycaemia is causing glucose levels to run higher than usual:

- Check for ketones and monitor glucose levels more closely
- Change the infusion set/cannula and insulin cartridge if glucose remains high, for 2 hours or more
- If ketones are >0.6 mmol/L give a correction dose of rapid acting insulin using an insulin pen

NOTE: If unsure how to calculate this dose, contact the diabetes team.

- Stop SmartGuard™ and run the pump in Manual Mode
- Set a Temp Basal Rate, increase if in Manual Mode, following discussion with team
- Drinking sugar-free fluid as well as eating carbohydrates, with insulin boluses, little and often. If unsure of what to eat or drink, always contact the diabetes team

- Always advise CYP/Carers to make contact with the diabetes team if glucose levels are high or during times of illness
- Recommence SmartGuard™ once glucose levels and ketones are resolving (0.6 mmol/mol or below)

Paracetamol

Paracetamol and other medication with acetaminophen, such as Tylenol®, fever reducers, or cold medicine, taken whilst wearing the sensor may falsely raise the CYP sensor glucose readings, although this may not affect everyone.

Always recommend switching to Manual Mode for 4 hours+ and use blood glucose readings for any insulin treatment decisions.

However, if individuals remain in SmartGuard™ advise to:

- Programme Temp Target for up to 8 hours
- Enter blood glucose readings into the pump, instead of using sensor readings, to deliver a meal or correction bolus for up to 8 hours