



Clinical Guideline

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

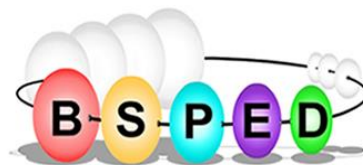
SETTING

FOR STAFF Medical and nursing staff

PATIENTS Children and young people with diabetes mellitus

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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.

1. Introduction

Illness generally raises 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 levels of stress hormones during illness contribute to high blood glucose levels. Cytokine release in response to infection can also lead to some degree of insulin resistance.²

Diarrhoea and vomiting may reduce blood glucose levels with a possibility of hypoglycaemia rather than hyperglycaemia. Ketones may still be produced in significant quantities even with hypoglycaemia in gastroenteritis³.

2. Importance of Local 'Sick-Day' Rules

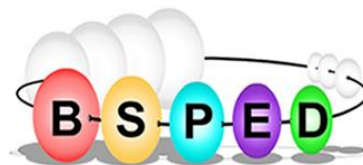
NICE guidelines recommend that children and young people with T1DM should be offered clear guidance for the management of diabetes during periods of illness⁴. Adequate sick day management at home may reduce the risk of progression to DKA and admission to hospital.⁴ The use of sick-day rules which include self-monitoring of blood glucose and ketones, and timely administration of supplemental insulin and fluids leads to reduced hospitalisation and potential cost savings.⁵ DKA admissions are associated more with increasing age, high HBA1c, high insulin doses and female sex.^{6,7}

3. 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 levels⁸. Blood beta-hydroxybutyrate levels > 0.5mmol/l is abnormal in children with diabetes.⁹

Urine ketone stick testing detects only acetoacetate and not beta-hydroxybutyrate¹⁰. The test is inconvenient, is not the best indicator of ketone body levels and provides only a semiquantitative



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. ^{1,8}

A recent systematic review has shown that blood testing is superior to urine for the prevention and management of DKA.¹¹ Near-patient capillary beta-hydroxybutyrate meters correlate well with superior laboratory methods but have limited precision and accuracy above 3mmol/l.¹² Capillary beta-hydroxybutyrate correlates with other biochemical markers of DKA¹³⁻¹⁶ and is more sensitive than urine testing in reflecting patient's metabolic state before and during treatment.¹⁷ 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.¹⁸

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.¹⁹

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

4. 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.^{20,21}

During intercurrent illness, the main reason for ensuring adequate hydration is to promote renal excretion of ketone bodies. However there appears to be scant direct evidence to support either the most appropriate fluid to be given or the volume of fluid. There is no evidence to support any specific drink/liquid. Water or other sugar-free drinks are probably most appropriate in the majority of cases where blood glucose is normal or high. Drinks with higher concentrations of glucose are only appropriate where blood glucose is low and starvation ketones thought to be prominent. Carbonation slows absorption from the stomach but recommendations suggest they may be considered if shaken or stirred to reduce carbonation²².

Recommendations –

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



5. 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 with DKA in children and young people with established diabetes. An Italian study showed that introduction of a toll free 24 hour hotline managed by staff with some experience in diabetes helped to avoid hospital admissions during sickness.²³ 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.²⁴

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 then there needs to be in place a process of ensuring the diabetes team is made aware of this contact
- The out of hours service should be regularly reviewed and audited

6. Diabetes Self Management Education

Diabetes self-management is the process of providing children and young people with diabetes education, knowledge and skills needed to successfully manage their diabetes²⁵ Children with better self management have reduced rates of DKA²⁶

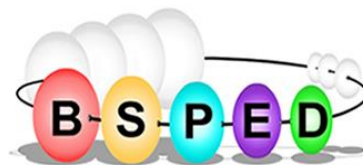
Recommendations -

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

7. 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 (ISPAD³, ADA²⁷, APEG²⁸) about the management of illness in children with diabetes are currently used. These recommendations are



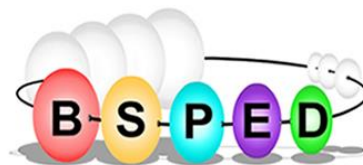
based on consensus and good practice. Practice in the UK is variable and there is no national consensus guideline on managing illness in children with Type 1 diabetes. ACDC has developed this guideline based on the best evidence available.

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.
 - 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)**
 - 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
- 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
- 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 normal or high
 - If blood glucose levels are low, drinks containing glucose are required, or take 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 <ul style="list-style-type: none"> • 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 	Give <ul style="list-style-type: none"> • 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
Then: <ul style="list-style-type: none"> • Re-check BG and ketones in two hours 	Then: <ul style="list-style-type: none"> • 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: <ul style="list-style-type: none"> • Monitor fluid intake and ensure you are drinking enough fluids to keep well-hydrated • Re-check BG & ketones in two hours (see below)
<p>If your BG is going down that is a good sign but monitor closely throughout the day.</p> <p>If BG is increasing but ketones less than 0.6mmol/l:</p> <ul style="list-style-type: none"> • Take another correction dose using a pen <p>If ketones 0.5 – 1.5mmol/l, follow orange column advice</p> <p>If ketones >1.5mmol/l, follow the red column advice</p>	<p>If ketones negative follow green column advice</p> <p>If BG is increasing but ketones still 0.6 – 1.5mmol/l:</p> <ul style="list-style-type: none"> • 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! <p>If ketones increase to >1.5mmol.l, follow the red column advice</p>	<p>If ketones negative follow green column advice</p> <p>If BG is increasing but ketones have reduced to 0.6 – 1.5mmol/l, follow orange column advice</p> <p>If ketones are still >1.5mmol.l:</p> <ul style="list-style-type: none"> • 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, have a low threshold for admission to hospital



7.1. Using sick day doses on pump therapy

The same principles of illness management apply to the 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 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.

7.2. Management of infections usually associated with hypoglycaemia eg. gastroenteritis

- Encourage regular small sips of sugar-containing drinks (NOT diet drinks)
- Monitor blood glucose (BG) at least 2 hourly,
- If not taking much orally and BG are in normal/low range, DECREASE usual fast acting insulin whilst illness persists.
- If BG are >10 but <14, give usual fast acting dose of insulin.
- If BG are >14, see above for extra insulin doses
- Once oral intake is tolerated again, give NORMAL dose of insulin
- If not tolerating anything orally and BG are <4, advise attend hospital. If drowsy or reduced conscious level, advise give 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 injectionOr
BNF guidance uses body weight
2-17 yrs (body weight less than 25kg) 500micrograms glucagon by IM injection
2-17y body weight >25kg for 1mg glucagon by IM injection
- If then able to tolerate oral intake and BG >4, can go home. If not tolerating anything orally or BG still <4, admit for observation and intravenous dextrose if necessary.



- If child has been vomiting and not eating, they may have ketones with NORMAL BG ('starvation ketones'). Monitor BG frequently and encourage fluids containing sugar
- If a child has HIGH (>14) BG, with ketones and is vomiting, this is DKA and they should be advised to attend hospital urgently.

8. References

1. Laffel L. Sick-day management in type 1 diabetes. *Endocrinology and metabolism clinics of North America* 2000;29:707-23.
2. Virkamäki A, Puhakainen I, Koivisto VA, Vuorinen-Markkola H, Yki-Järvinen H. Mechanisms of hepatic and peripheral insulin resistance during acute infections in humans. *The Journal of Clinical Endocrinology & Metabolism* 1992;74:673-9.
3. Brink S, Joel D, Laffel L, et al. Sick day management in children and adolescents with diabetes. *Pediatric diabetes* 2014;15 Suppl 20:193-202.
4. National Institute for Health and Care Excellence (NICE) NG18. Diabetes (Type 1 and Type 2) in children and young people: diagnosis and management August 2015. <https://www.nice.org.uk/guidance/ng18>
5. Bismuth E, Laffel L. Can we prevent diabetic ketoacidosis in children? *Pediatric diabetes* 2007;8 Suppl 6:24-33.
6. Fritsch M, Rosenbauer J, Schober E, Neu A, Placzek K, Holl RW. Predictors of diabetic ketoacidosis in children and adolescents with type 1 diabetes. Experience from a large multicentre database. *Pediatric diabetes* 2011;12:307-12.
7. Kanwal SK, Bando A, Kumar V. Clinical profile of diabetic ketoacidosis in Indian children. *Indian journal of pediatrics* 2012;79:901-4.
8. Laffel L. Ketone bodies: a review of physiology, pathophysiology and application of monitoring to diabetes. *Diabetes/metabolism research and reviews* 1999;15:412-26.
9. Samuelsson U, Ludvigsson J. When should determination of ketonemia be recommended? *Diabetes technology & therapeutics* 2002;4:645-50.
10. Comstock J, Garber A. In: Walker H, Hall W, Hurst J, eds. *Clinical Methods: The History, Physical, and Laboratory Examinations*. 3rd ed: Boston: Butterworths; 1990.
11. Klocker AA, Phelan H, Twigg SM, Craig ME. Blood beta-hydroxybutyrate vs. urine acetoacetate testing for the prevention and management of ketoacidosis in Type 1 diabetes: a systematic review. *Diabetic medicine : a journal of the British Diabetic Association* 2013;30:818-24.
12. Rewers A, McFann K, Chase HP. Bedside monitoring of blood beta-hydroxybutyrate levels in the management of diabetic ketoacidosis in children. *Diabetes technology & therapeutics* 2006;8:671-6.
13. Lertwattanarak R, Plainkum P. Efficacy of quantitative capillary beta-hydroxybutyrate measurement in the diagnosis of diabetic ketoacidosis: a comparison to quantitative serum ketone measurement by nitroprusside reaction. *Journal of the Medical Association of Thailand = Chotmai het thangphaet* 2014;97 Suppl 3:S78-85.
14. Naunheim R, Jang TJ, Banet G, Richmond A, McGill J. Point-of-care test identifies diabetic ketoacidosis at triage. *Academic emergency medicine : official journal of the Society for Academic Emergency Medicine* 2006;13:683-5.
15. Ham MR, Okada P, White PC. Bedside ketone determination in diabetic children with hyperglycemia and ketosis in the acute care setting. *Pediatric diabetes* 2004;5:39-43.
16. Sheikh-Ali M, Karon BS, Basu A, et al. Can serum beta-hydroxybutyrate be used to diagnose diabetic ketoacidosis? *Diabetes care* 2008;31:643-7.



17. Turan S, Omar A, Bereket A. Comparison of capillary blood ketone measurement by electrochemical method and urinary ketone in treatment of diabetic ketosis and ketoacidosis in children. *Acta diabetologica* 2008;45:83-5.
18. Laffel LM, Wentzell K, Loughlin C, Tovar A, Moltz K, Brink S. Sick day management using blood 3-hydroxybutyrate (3-OHB) compared with urine ketone monitoring reduces hospital visits in young people with T1DM: a randomized clinical trial. *Diabetic medicine : a journal of the British Diabetic Association* 2006;23:278-84.
19. Orsini-Federici M, Akwi JA, Canonico V, et al. Early detection of insulin deprivation in continuous subcutaneous insulin infusion-treated patients with type 1 diabetes. *Diabetes technology & therapeutics* 2006;8:67-75.
20. Ugale J, Mata A, Meert KL, Sarnaik AP. Measured degree of dehydration in children and adolescents with type 1 diabetic ketoacidosis. *Pediatric critical care medicine : a journal of the Society of Critical Care Medicine and the World Federation of Pediatric Intensive and Critical Care Societies* 2012;13:e103-7.
21. Sottosanti M, Morrison GC, Singh RN, et al. Dehydration in children with diabetic ketoacidosis: a prospective study. *Archives of disease in childhood* 2012;97:96-100.
22. Poudroux P, Friedman N, Shirazi P, Ringelstein JG, Keshavarzian A. Effect of carbonated water on gastric emptying and intragastric meal distribution. *Digestive diseases and sciences* 1997;42:34-9.
23. Chiari G, Ghidini B, Vanelli M. Effectiveness of a toll-free telephone hotline for children and adolescents with type 1 diabetes. A 5-year study. *Acta bio-medica : Atenei Parmensis* 2003;74 Suppl 1:45-8.
24. Franklin BE, Crisler SC, Jr., Shappley R, Armour MM, McCommon DT, Ferry RJ, Jr. Real-time support of pediatric diabetes self-care by a transport team. *Diabetes care* 2014;37:81-7.
25. Schilling LS, Grey M, Knafel KA. The concept of self-management of type 1 diabetes in children and adolescents: an evolutionary concept analysis. *Journal of advanced nursing* 2002;37:87-99.
26. Campbell MS, Schatz DA, Chen V, et al. A contrast between children and adolescents with excellent and poor control: the T1D Exchange clinic registry experience. *Pediatric diabetes* 2014;15:110-7.
27. Silverstein J, Klingensmith G, Copeland K, et al. Care of children and adolescents with type 1 diabetes: a statement of the American Diabetes Association. *Diabetes care* 2005;28:186-212.
28. Craig M, Twigg S, Donaghue K, et al. National evidence-based clinical care guidelines for type 1 diabetes in children, adolescents and adults. . In: Ageing AGDoHa, ed. Canberra2011.



9. Appendix

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 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



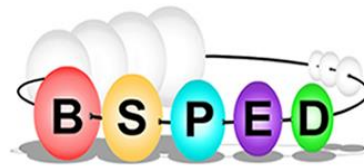
- b. If blood glucose levels are low, drinks containing sugar are required, or eat carbohydrates if possible.
 - c. Avoid carbonated drinks if possible
6. Inform the diabetes team early to seek advice

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 glucoses are 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 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.

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 <ul style="list-style-type: none"> 10% of your total daily dose (TDD) of insulin as additional fast acting insulin <p style="text-align: center;">OR</p> <ul style="list-style-type: none"> 0.1 units/kg body weight as additional fast acting insulin 	Give <ul style="list-style-type: none"> 20% of your total daily dose (TDD) of insulin as additional fast acting insulin. <p style="text-align: center;">OR</p> <ul style="list-style-type: none"> 0.2 units/kg body weight as additional fast acting insulin
Then: <ul style="list-style-type: none"> Re -check BG and ketones in two hours 	Then: <ul style="list-style-type: none"> 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: <ul style="list-style-type: none"> 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: <ul style="list-style-type: none"> Take another correction 	If ketones negative follow green column advice If BG is increasing but ketones still 0.6 – 1.5mmol/l: <ul style="list-style-type: none"> Continue to give 10% of TDD or 0.1 Units/kg as additional 	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



<p>dose using a pen</p> <p>If ketones 0.5 – 1.5mmol/l, follow orange column advice</p> <p>If ketones >1.5mmol/l, follow the red column advice</p>	<p>fast acting insulin every 2 hours using a pen</p> <ul style="list-style-type: none">• Give usual boluses for food• Re-check BG and ketones every 2 hours even through the night! <p>If ketones increase to >1.5mmol.l, follow the red column advice</p>	<p>If ketones are still >1.5mmol.l:</p> <ul style="list-style-type: none">• 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
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