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Norfolk and Norwich University Hospitals NHS
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Management of DKA and HHS

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Controversies in the Management of DKA and HHS

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Disclosures

- In the last 12 months I have received honoraria, travel or fees for advisory boards from
  - AstraZeneca
  - Novo Nordisk
  - Boehringer-Ingelheim
  - Eli Lilly

Diagnostic Criteria – ADA and JBDS

	DKA		
	Mild (plasma glucose >250 mg/dl)	Moderate (plasma glucose >250 mg/dl)	Severe (plasma glucose >250 mg/dl)
Arterial pH	7.25–7.30	7.00 to <7.24	<7.00
Serum bicarbonate (mEq/l)	15–18	10 to <15	<10
Urine ketone	Positive	Positive	Positive
Serum ketone	Positive	Positive	Positive
Effective serum osmolality	Variable	Variable	Variable
Anion gap	>10	>12	>12
Mental status	Alert	Alert/drowsy	Stupor/coma

DIAGNOSIS:

Ketonaemia ≥ 3.0mmol/L **or** significant ketonuria (more than 2+ on standard urine sticks)

Blood glucose > 11.0mmol/L or known diabetes mellitus (200 mg/dL)

Bicarbonate (HCO_3^-) < 15.0mmol/L **and/or** venous pH < 7.3

ADA, American Diabetes Association; DKA, diabetic ketoacidosis; JBDS, Joint British Diabetes Societies.

Kitabchi AE, *et al. Diabetes Care* 2009;32:1335–1343;

Association of British Clinical Diabetologists. Joint British Diabetes Societies (JBDS) for Inpatient Care Group.

The management of diabetic ketoacidosis (DKA) in adults | ABCD (Diabetes Care) Ltd

Differences

Table 1 UK vs USA diagnostic criteria for DKA

		UK	USA		
			Mild	Moderate	Severe
"D"—a glucose concentration		>11.0 mmol/L (200 mg/dL) or a previous history of diabetes mellitus	>13.9 mmol/L (>250 mg/dL)	>13.9 mmol/L (>250 mg/dL)	>13.9 mmol/L (>250 mg/dL)
"K"—the presence of ketones		>3.0 mmol/L or significant (>2+) on standard urine ketone sticks	Urine or serum ketone positive	Urine or serum ketone positive	Urine or serum ketone positive
"A"—confirmation of an acidosis	pH	<7.3	7.25 to 7.30	7.00 to <7.24	<7.00
	Serum bicarbonate (mmol/L)	<15	15 to 18	10 to <15	<10
	Anion gap	Not applicable	>10	>12	>12

Dhatariya KK et al Curr Diab Rep 2017;17(5):33-39

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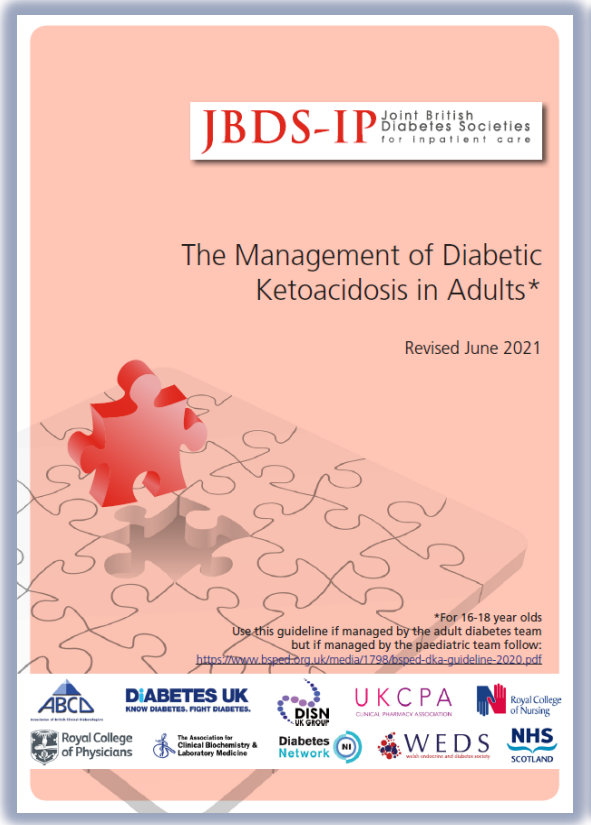
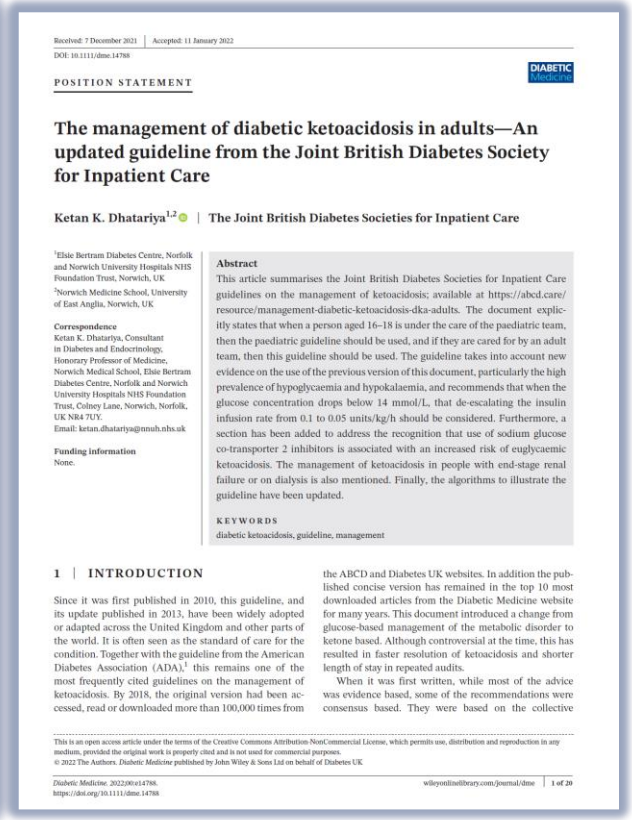
For Those Not Familiar with JBDS





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POSITION STATEMENT

DIABETIC Medicine

The management of diabetic ketoacidosis in adults—An updated guideline from the Joint British Diabetes Society for Inpatient Care

Ketan K. Dhatariya[1,2] | The Joint British Diabetes Societies for Inpatient Care

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None.

Abstract
This article summarises the Joint British Diabetes Societies for Inpatient Care guidelines on the management of ketoacidosis; available at https://abcd.care/resource/management-diabetic-ketoacidosis-dka-adults. The document explicitly states that when a person aged 16–18 is under the care of the paediatric team, then the paediatric guideline should be used, and if they are cared for by an adult team, then this guideline should be used. The guideline takes into account new evidence on the use of the previous version of this document, particularly the high prevalence of hypoglycaemia and hypokalaemia, and recommends that when the glucose concentration drops below 14 mmol/L, that de-escalating the insulin infusion rate from 0.1 to 0.05 units/kg/h should be considered. Furthermore, a section has been added to address the recognition that use of sodium glucose co-transporter 2 inhibitors is associated with an increased risk of euglycaemic ketoacidosis. The management of ketoacidosis in people with end-stage renal failure or on dialysis is also mentioned. Finally, the algorithms to illustrate the guideline have been updated.

KEYWORDS
diabetic ketoacidosis, guideline, management

1 | INTRODUCTION

Since it was first published in 2010, this guideline, and its update published in 2013, have been widely adopted or adapted across the United Kingdom and other parts of the world. It is often seen as the standard of care for the condition. Together with the guideline from the American Diabetes Association (ADA),[1] this remains one of the most frequently cited guidelines on the management of ketoacidosis. By 2018, the original version had been accessed, read or downloaded more than 100,000 times from the ABCD and Diabetes UK websites. In addition the published concise version has remained in the top 10 most downloaded articles from the Diabetic Medicine website for many years. This document introduced a change from glucose-based management of the metabolic disorder to ketone based. Although controversial at the time, this has resulted in faster resolution of ketoacidosis and shorter length of stay in repeated audits.

When it was first written, while most of the advice was evidence based, some of the recommendations were consensus based. They were based on the collective

[The management of diabetic ketoacidosis (DKA) in adults | ABCD (Diabetes Care) Ltd]

Dhatariya K for the Joint British Diabetes Societies for Inpatient Care Diabetic Medicine 2022;39:e14788

What Guidelines are Those Then?

- *The hospital management of hypoglycaemia in adults with diabetes mellitus* *JBDS 01*
- *The management of diabetic ketoacidosis in adults* *JBDS 02*
- *Management of adults with diabetes undergoing surgery and elective procedures: improving standards* *JBDS 03*
- *Self-management of diabetes in hospital* *JBDS 04*
- *Glycaemic management during the inpatient enteral feeding of stroke patients with diabetes** *JBDS 05*
- *The management of the hyperosmolar hyperglycaemic state (HHS) in adults with diabetes* *JBDS 06*
- *Admissions av* *JBDS 07*
- *Management* *JBDS 08*
- *The use of var* *JBDS 09*
- *Discharge planning for adult inpatients with diabetes* *JBDS 10*
- *Management of adults with diabetes on the haemodialysis unit** *JBDS 11*
- *Management of glycaemic control in pregnant women with diabetes on obstetric wards and delivery units* *JBDS 12*
- *The management of diabetes in adults and children with psychiatric disorders in inpatient settings** *JBDS 13*
- *A good inpatient diabetes service* *JBDS 14*
- *Inpatient care of the frail older adult with diabetes* *JBDS 15*
- *Diabetes at the front door* *JBDS 16*
- *Diabetes in people living with cancer* *JBDS 17*
- *Diabetes related devices in the hospital**

Type “JBDS Guidelines” into Google

*Being worked on

You May Have Seen This

Diabetes Care Volume 45, February 2022 267

Check for updates

Controversies Around the Measurement of Blood Ketones to Diagnose and Manage Diabetic Ketoacidosis

Eric S. Kilpatrick,[1] Alexandra E. Butler,[2] Linda Ostlundh,[3] Stephen L. Atkin,[2] and David B. Sacks[4]

Diabetes Care 2022;45:267–272 | https://doi.org/10.2337/dc21-2279

Kilpatrick ES et al Diabetes Care 2022;45(2):267-272

Diagnosis

- To diagnose DKA you need to have
  - The ‘D’ – a history of diabetes or a glucose >200mg/dl (11.1mmol/l)
  - The ‘K’ – blood ketones ≥3.0 mmol/l or >2+ ketone on urine testing
  - The ‘A’ – a pH of <7.3 and/or a bicarbonate of <15mmol/l or <18mmol/l ideally with a high anion gap

2009 ADA Consensus Guideline

- No insistence on the ‘D’, the ‘K’, and the ‘A’ to diagnose DKA
- No clear acknowledgement of euglycaemic DKA
- No recommendation to use bedside ketone measurements to monitor and guide treatment
- No recommendation to continue long acting subcutaneous insulin

Guidelines for management of diabetic ketoacidosis: time to revise?

Dhatariya K et al Lancet Diab Endocrinol 2017;5(5):321-323

Euglycaemic DKA?

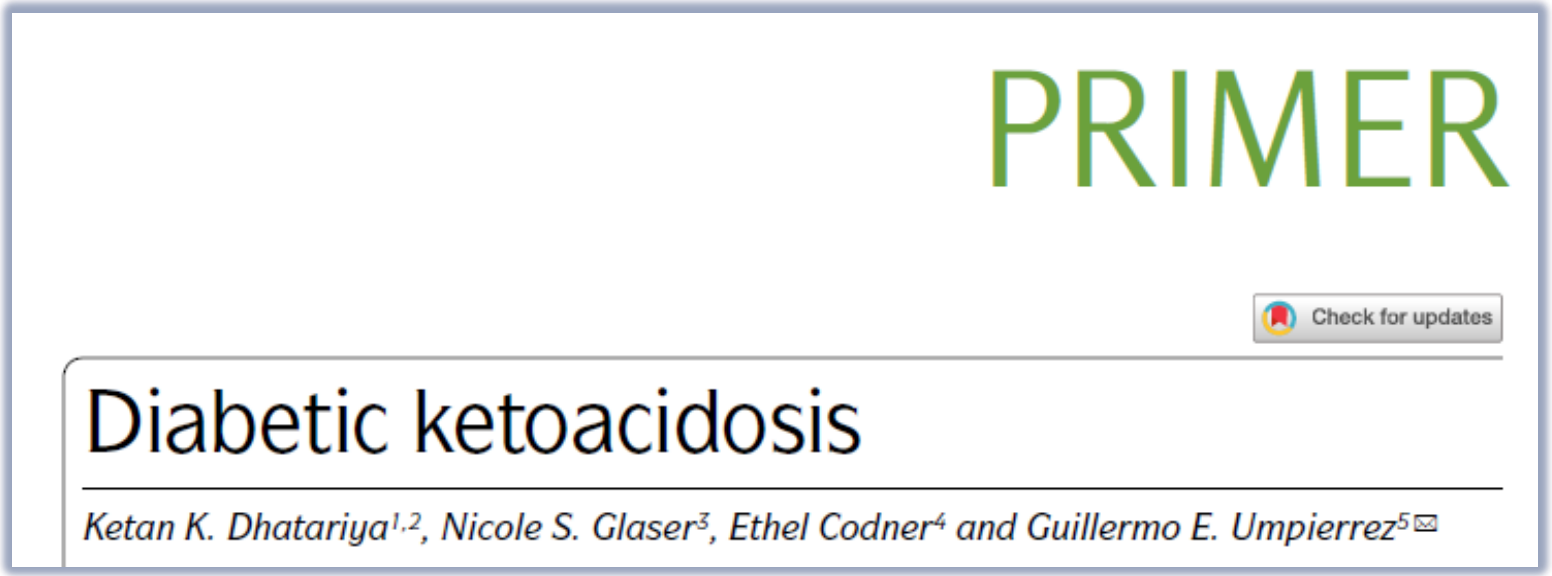
TABLE. Prevalence of Euglycemic Diabetic Ketoacidosis in People With Type 1 Diabetes in the United Kingdom[a]

	Number	Admission glucose <11.0 mmol/L (200 mg/dL)[1]	Admission glucose <13.9 mmol/L (250mg/dL)[2]	Admission glucose <16.7 mmol/L (300 mg/dL)[3]
National survey (2014)[4]	277	6	14	23
Local audit (2015)[5]	57	4	4	6
	334	10	18	29
		3.0%	5.4%	8.7%

[a]Data from a national survey[4] and local audit.[5] Data are divided into different thresholds of "euglycemia."

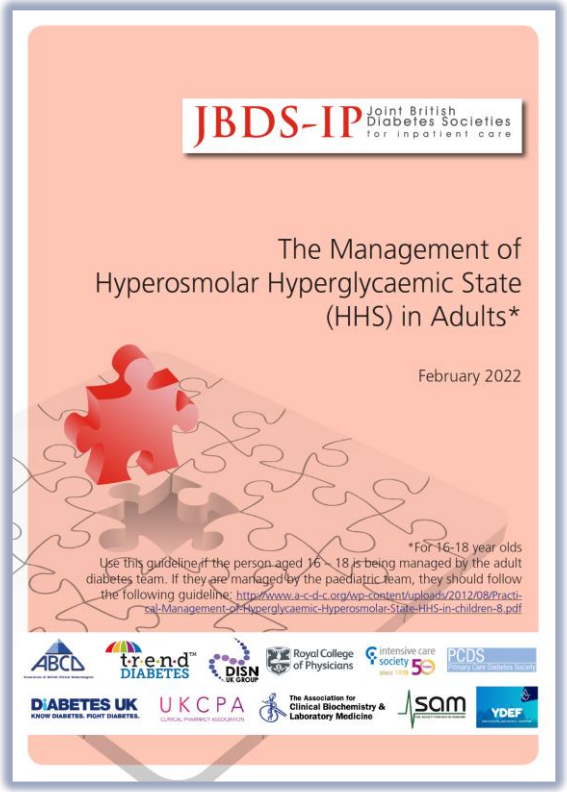
Munro JF et al BMJ 1973;2(5866):578-5880
Kitabchi AE et al Diab Care 2009;32(7):1335-1343
Dhatariya K et al Diab Med 2016;33(2):252-260
Macfarlane J et al Mayo Clin Proc 2019;94(9):1909-1910

If Anyone is Interested



Dhatariya K et al Nature Rev Dis Primers 2020;6:40

Hyperosmolar Hyperglycaemic Syndrome



[Management of Hyperosmolar Hyperglycaemic State (HHS) | ABCD (Diabetes Care) Ltd]

Fewer Differences

Table 2 UK vs USA diagnostic criteria for HHS

		UK	USA
Hyperglycemia		>30 mmol/L (540 mg/dL)	>33.3 mmol/L (600 mg/dL)
Hyperosmolarity		>320 mOsm/kg	>320 mOsm/kg
	Calculation	2 × Na (mmol/L) + glucose (mmol/L) + urea (mmol/L)	2 × Na (meQ/L) + glucose (mg/dL)/18 + blood urea nitrogen (mg/dL)]/2.8
Lack of acidosis	Ketones	Low	Low
	pH	>7.3	>7.3
	Bicarbonate	>15 mmol/L	>20 mmol/L
Mental status changes		Present	Present

- No unified diagnostic criteria
- HHS and DKA frequently occur together – treat as DKA
- No clear criteria for resolution

Dhatariya KK et al Curr Diab Rep 2017;17(5):33-39

HHS - Criteria for Resolution

- Calculated serum osmolality falls to <300 mOsm/Kg
- Hypovolaemia has been corrected (urine output ≥0.5 ml/kg/hr)
- Cognitive status is back to the pre-morbid state
- Blood glucose <15 mmol/L (270mg/dl)

Management of Hyperosmolar Hyperglycaemic State (HHS) | ABCD (Diabetes Care) Ltd

In Summary

- Guidelines for DKA and HHS exist but are (subtly) different in places
- The ADA Consensus document is quite outdated
- There remain gaps in the evidence for what we do, but for the time being, these documents seem to work well

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