

Diabetic ketoacidosis in the UK paediatric population: management and outcomes compared to British Society of Paediatric Endocrinology and Diabetes guidelines; a large single centre study

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Background

- The British Society for Paediatric Endocrinology and Diabetes have produced guidelines for the management of diabetic ketoacidosis (DKA) in paediatrics since 1994.
- They have most recently been updated in 2009 & 2015.
- Two recent national surveys compared guideline uptake with management and outcomes in adults (Dhatariya et al, 2016) and adolescents & young adults (Edge et al 2016).
- This is the first study comparing the management and outcomes against BSPED 2009 guidelines in the paediatric population.

Methods

- 99 admissions of patients aged 1-17 presenting with suspected diabetic ketoacidosis (DKA) to a large tertiary UK hospital between 2012-2014.
- A questionnaire was developed using the BSPED 2009 DKA guidelines, and data collected by a single author from patient notes
- Patient outcomes were compared against national guidelines set by BSPED (2009)

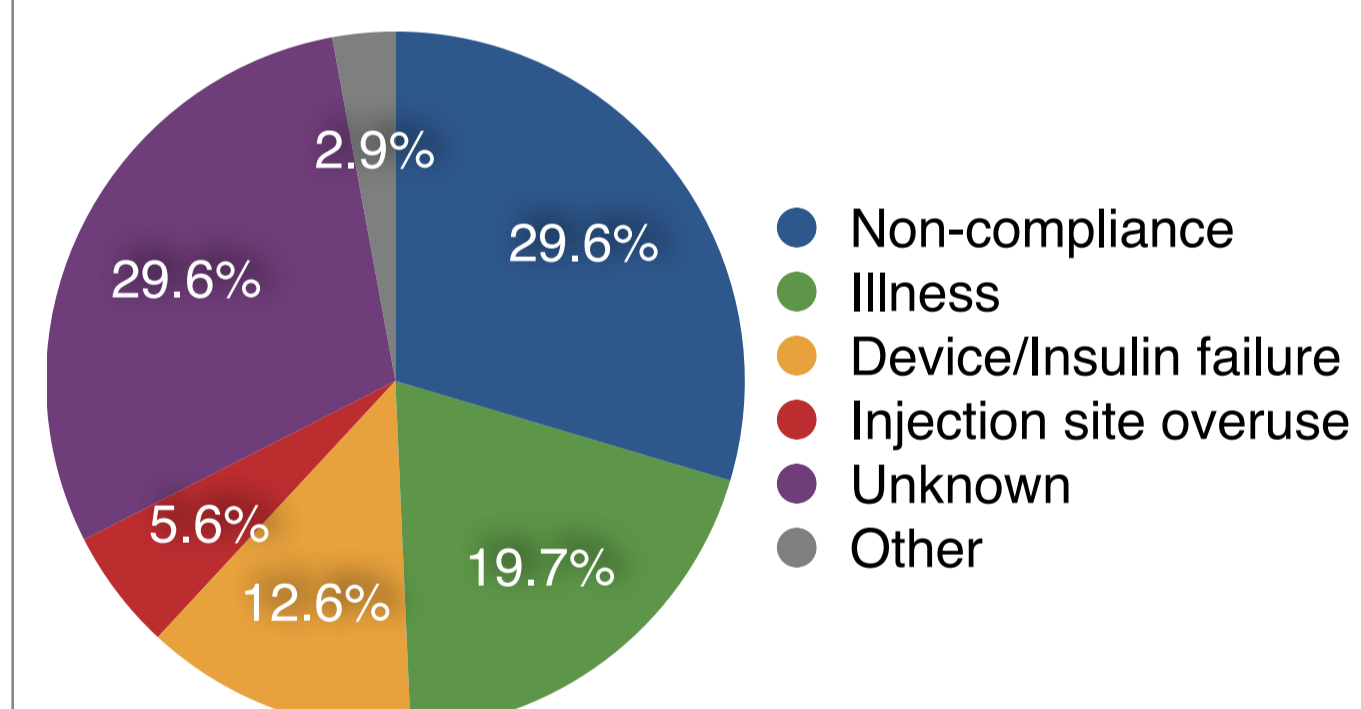
Demographics

- 48.5% Male, 51.5% Female
- Mean age **12.2 years** (SD = 4.6), Median age 14 years
- 76.8% known type 1 diabetes mellitus
- 14.1% had 1 previous admission in previous year, 12.8% had >2 (mean = 0.47 admissions)
- 75.8% managed in paediatrics, 24.2% emergency and adult

Diagnosis

- BSPED 2009 Guidelines for diagnosis
 - Blood glucose >11.0 mmol/L (or known diabetic)
 - venous pH <7.3 and/or bicarbonate <15 mmol/L
- 74.7% Diabetic Ketoacidosis (BK > 3.0 mmol/L)
- 16.2% Diabetic Ketosis without acidosis (BK > 3.0 mmol/L)
- 9.1% Hyperglycaemia

Precipitants

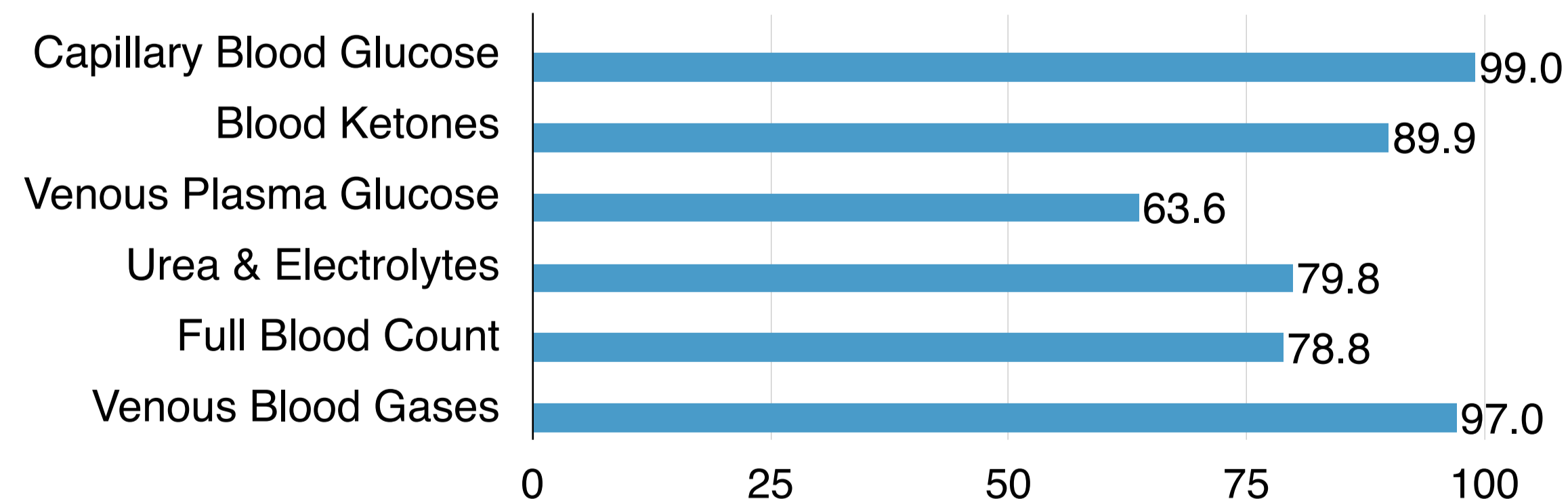


Admission Biochemistry

	Mean (mmol/L)	SD (mmol/L)
pH	7.21	0.13
BM	20.9	7.2
BK	4.7	1.4
HCO3	12.9	4.4
K+	5.0	1.2

Initial Management (0-1 hours)

Investigations performed on admission (%)



Time to investigations

	Yes (<1h, %)	Yes (>1h, %)	Yes (NR, %)	No (%)	Mean time
U&Es	43.4	30.3	6.1	20.2	1h 18min
FBC	45.5	27.3	6.1	21.2	0h 55min
VBG	79.8	14.1	3.0	3.0	0h 37min

Time to management (DKA patients only, n=74)

	Yes (<1h, %)	Yes (>1h, %)	Yes (NR, %)	No (%)	Mean time
0.9% NaCl given?	56.8	25.7	5.4	12.2	0h 56min
FRIII given?	12.2	62.2	5.4	20.3	1h 57min

Continuing Management (1-24 hours)

Continued monitoring, comparing those managed in paediatric and adult departments

	Paediatric (%)	Adult (%)
BM	84.0	70.8
BK	82.7	33.3
EWS	81.3	20.8
Vital signs	77.3	20.8
Urine output	66.7	58.3

- No patients received 0.05 units/kg infusion on commencement of FRIII.
- 39.3% of those with T1DM who took long-acting insulin prior to admission, continued it during their FRIII.
- 57.6% were reviewed by a senior within 1h, 93.9% within 12 hours.
- Mean time to resolution of DKA (pH >7.3 or HCO3 >15 mmol/L, BK <1.0 mmol/L) = **13h 35 mins**, although complete resolution not demonstrated in 31.1%.
- Mean time to discharge **33h 40 mins** (SD = 31h 28 min).

Biochemical Changes

Hypokalaemia

- Only 60.2% of patients had potassium correctly added to their IV fluids
- 74.7% of patients had potassium outside of the range of 4.0-5.5
- 24.2% becoming hypokalaemic (<3.5 mmol/L)
 - 52.2% of those who became hypokalaemic had potassium appropriately added
- Mean lowest K = **3.94 mmol/L** (SD = 0.71)

Hypoglycaemia

- Only 48.0% had dextrose suitably added to fluids when BM fell <14 (0.0% adult medicine, 80.0% paediatrics, highlighting differences between BSPED & JBDS guidelines)
- 18.2% of patients became hypoglycaemic during the first 24 hours of their admission (20.8% adult medicine, 17.3% paediatrics).
 - Of the patients who became hypoglycaemic, dextrose was only correctly added when BM fell <14, in 33.3%.
 - Mean duration = 1h 10min, mean low = 3.26 mmol/L, SD = 0.44), mean 16h 58min after admission, SD = 10h 52min)

Changes to BSPED guidelines 2015

- Diagnostic criteria changes - acidosis (pH <7.3, HCO3 < 18 mmol/L) and ketonaemia BK > 3.0 mmol/L)
- De-emphasise on STAT fluids on admission
- Reduced maintenance fluid rates
- Option to start FRIII at **0.05 - 0.1 units/kg/h** 1-2 hours after fluids, rather than 0.1 units/kg/h, 1 hour after fluids
- Guidance on when to change to 0.05 units/kg/h (BK <3.0 mmol/L)

Conclusions

- We believe this is the largest, single centre study comparing guidelines uptake, management and outcomes in this demographic.
- It has highlighted a number of areas for improvement at both local and national levels.
- At least 67.5% of admissions in known T1DM are **preventable**, through education promoting better adherence, sick day rules, injection site rotation and device management.
- There were significant **delays in delivery of investigations and administration of IV fluids** and approaches to improving this process should be explored.
- There was **poor adherence to guideline recommendations** in some areas, notably, continued **monitoring in adult medicine**, and the appropriate supplementation of IV fluids with **dextrose and potassium**.
- Locally, discussion is needed to decide in which department and with which guideline **16-18 year olds** should be treated with.
- Nearly 1/5 became **hypoglycaemic**, and this can not be entirely attributable to poor guideline adherence. The updated guidelines may help, but possibly at the expense of preventing ketosis and delaying resolution time.
- Nearly 1/4 became **hypokalaemic**. Again this can not be entirely attributable to poor guideline adherence. Further discussion is required to determine whether more aggressive potassium supplementation would be appropriate.

References

- Dhatariya KK, Nunney I, Higgins M, Sampson MJ, and Iceton G. National survey of the management of Diabetic Ketoacidosis (DKA) in the UK in 2014. Diabetic Medicine, 2016, 33 (2), 252-260.
- Edge JA, Nunney I, and Dhatariya KK. Diabetic ketoacidosis in an adolescent and young adult population in the UK in 2014: a national survey comparison of management in paediatric and adult settings. Diabetic Medicine, 2016 10.1111/dme.13065
- British Society for Paediatric Endocrinology and Diabetes Recommended DKA Guidelines, 2009
- BSPED Recommended Guideline for the Management of Children and Young People under the age of 18 years with Diabetic Ketoacidosis, 2015