

The Effect of a Reduced Fluid Replacement Regimen on the Resolution of Diabetic Ketoacidosis (DKA) in Children



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Background

There have been concerns that rapid fluid replacement in diabetic ketoacidosis (DKA) in children may propagate the potential complication of cerebral oedema. As a result, a substantially reduced fluid replacement regimen was introduced in the 'New' British Society of Paediatric Endocrinology Diabetes guideline (2015) compared to the 'Old' (2009) guideline for DKA management; this involved a marked reduction in the fluid administration rates (table 1). Currently, the data on the effect of varying fluid replacement regimens on the resolution of DKA is limited; therefore we explored this by comparing outcomes of the two guidelines.

Methods

A retrospective study was performed on consecutively admitted patients (age <18yrs) with DKA over a 3-year period (Jan-2014 and March-2017) in two hospitals within the Bart's Health NHS Trust, London, UK. The resolution of DKA was defined by the recovery of acidosis (pH >7.30), ketosis (blood ketones <1.0mmol/l) or improvement in bicarbonate levels >18.0mmol/l. Biochemical parameters before treatment, then nearest to 4 and 10 hours into treatment and at resolution, and time to decline in glucose <14mmol/L were collected. Effective osmolality was calculated using the formula: [2xSodium (mmol/l)]+glucose (mmol/l).

Results

During the 3-year period, there were 82 admissions with DKA; 27 patients were excluded due to incomplete data (n=11), transfers (n=12) or being managed with subcutaneous insulin (n=4). Of the remaining 55 patients, 23 (8 male) were managed using the 'New' and 32 (15 male) by the 'Old' guidelines. The mean age of patients was 10.1yrs (SD±4.1), 36 patients (65.5%) were newly-diagnosed and 15 (27.3%) had severe DKA (pH <7.1). Age, severity of DKA and proportion of newly-diagnosed patients were similar in both groups.

The fluid administration rates were substantially lower in the 'New' guideline, but the frequency of fluid boluses and insulin administration rates were similar (Table 2). There was no significant difference in DKA resolution times evaluated by pH or ketosis or bicarbonate levels (Fig 1). The levels of glucose, Na, K, Cl and HCO₃⁻, and pH at presentation, 4 and 10 hours of starting treatment and resolution, and hypoglycaemia rates were similar (Table 3). However, in patients with mild DKA managed by the 'New' guideline, the time taken for glucose levels to decline to 14mmol/l tended to be lower (5.0 ±3.7 vs 7.4 ±4.0 hours, p=0.07) and the rate of decline in effective osmolality was faster at 4 hours (8.9 ±4.4 vs 4.9 ±6.4 mosm/l/hour, p=0.038) and at 10 hrs (2.8±1.0 vs 1.7±1.2 mosm/l/hour, p=0.032). No patients developed cerebral oedema.

Conclusion

We found that a 50% reduction in the fluid replacement in DKA was not associated with significant changes in resolution time or specific electrolyte levels. However, in patients with mild DKA, decline glucose and effective osmolality was faster with the reduced fluid replacement. Larger studies are important to evaluate the effects on cerebral oedema.

Weight	'New' Guideline		'Old' Guideline		% Reduction	
	Total Fluid/hour (ml/hr)		Total Fluid/hour (ml/hr)		Mild DKA	Severe DKA
	Mild DKA	Severe DKA	Mild DKA	Severe DKA		
10 kg	20	31	40	50	50	38
20 kg	41	62	58	79	29	22
40 kg	82	123	100	142	18	13

Table 1. Demonstrates the differences in fluid administration rates (maintenance fluid + correction for dehydration over 48 hours) between 'New' and 'Old' two guidelines for example weights.

Mean(SD)	'New' Guideline	'Old' Guideline	P-value
Treatment -Fluids			
Fluid Administration rates (ml/kg/day)	29.5 ±9.6	58.1 ±16.8	< 0.001
Number of patients who received fluid bolus n(%)	9 (39%)	16 (50%)	0.57
Treatment- Insulin			
Rate of insulin infusion (kg/hr)	0.05 ±0.01	0.05 ± 0.01	0.65

Table 2. Fluid and insulin management.

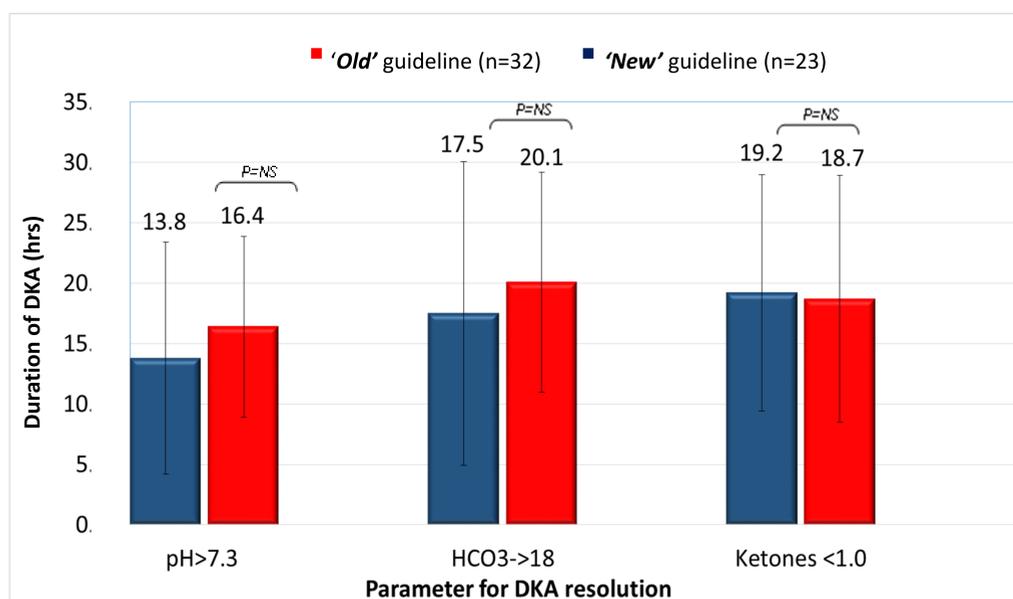


Fig 1. Graph comparing the resolution times of DKA (mean ± SD) between the 'New' and 'Old' guidelines, with end point parameters as pH, bicarbonate and ketones.

Mean (SD)	Baseline			4 Hrs			10 Hrs		
	'New' Guideline	'Old' Guideline	P Value	'New' Guideline	'Old' Guideline	P Value	'New' Guideline	'Old' Guideline	P Value
pH	7.18 ± 0.11	7.14 ± 0.11	0.20	7.22 ± 0.12	7.11 ± 0.52	0.35	7.27 ± 0.09	7.28 ± 0.1	0.58
Bicarbonate (mmol/l)	11.9 ± 4.5	11.2 ± 3.9	0.57	12.9 ± 5.3	11.9 ± 4.3	0.49	15.0 ± 4.3	15.9 ± 3.5	0.50
Sodium (mmol/l)	136 ± 6.4	135 ± 5.4	0.83	139 ± 6.5	141 ± 5.8	0.21	141 ± 4.2	143 ± 6.0	0.35
Potassium (mmol/l)	4.5 ± 0.7	4.5 ± 1.1	0.91	4.6 ± 0.9	4.4 ± 1.1	0.57	4.2 ± 0.8	4.2 ± 0.9	0.85
Chloride (mmol/l)	104 ± 4.8	104 ± 6.8	0.99	110 ± 6.3	113 ± 8.4	0.29	115 ± 6.0	117 ± 7.1	0.36
Effective osmolality (mmol/l)	324 ± 20.1	323 ± 14.4	0.85	304 ± 16.6	309 ± 16.0	0.24	283 ± 70.7	305 ± 13.7	0.13

Table 3. Biochemical parameters at baseline (at presentation), 4 and 10 hours into treatment