Evaluation of a Two-Bag Intravenous Fluid Protocol in Pediatric Diabetic Ketoacidosis

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BACKGROUND

- Diabetic ketoacidosis (DKA) is an acute life-threatening condition that can present in children and adolescents with type 1 diabetes mellitus (T1DM).
- DKA management includes prompt fluid resuscitation, insulin administration, and electrolyte replacement, along with close monitoring for signs of cerebral edema.
- One method utilized for fluid resuscitation is the two-bag system. In this system, two intravenous fluid bags with identical electrolyte concentrations but different dextrose concentrations are administered simultaneously. Rate of administration of the two fluids can be adjusted to vary the dextrose concentration to meet the patient's requirements while the insulin, electrolytes, and the overall rate of administration of fluid remain constant. In this study we sought to evaluate whether the two-bag system improves the time to recovery in pediatric DKA.

METHOD

- This was a retrospective chart review of patients who were admitted between 2012 and 2020 for diagnosis of DKA.
- Inclusion criteria: age ≤18 years old, confirmed diagnosis of diabetic ketoacidosis, admitted to Pediatric Intensive Care Unit (PICU) and started on insulin drip.
- Exclusion criteria: pregnancy, external emergency department visit, history of adrenal insufficiency or systemic steroids during admission.
- Primary outcome was time to resolution of acidosis (defined as serum bicarbonate ≥ 17).
- Secondary outcomes evaluated process efficiency of two-bag protocol (time to transition to subcutaneous (SC) insulin, number of wasted IV fluid bags and duration of ICU stay.
- Data was collected into REDCap. Continuous variables were analyzed using 2-sided t-tests or Mann-Whitney U if not-parametric. Nominal data were analyzed using Fisher's exact test.

RESULTS

Table 1. Baseline characteristics

	1-Bag System (n=24)	2-Bag System (n=22)
Age (years)	14.1±2.8	13.1±3.6
Sex, Male	8	7
Initial glucose (mg/dL)	415.6±154.1	450.8±120.8
Initial bicarb (mEq/dL)	10.2±3.4	11.6±3.0
Initial venous pH	7.18±0.08	7.2±0.09
Initial anion gap	25.6±5.9	23.8±4,6
HbA1c	9.9±1.8	9.6±1.2
Initial K	5.1±0.9	4.9±0.5
Initial Na	138.8±3.6	136.5±2.9

Figure 1. Diagram of the two bag system.

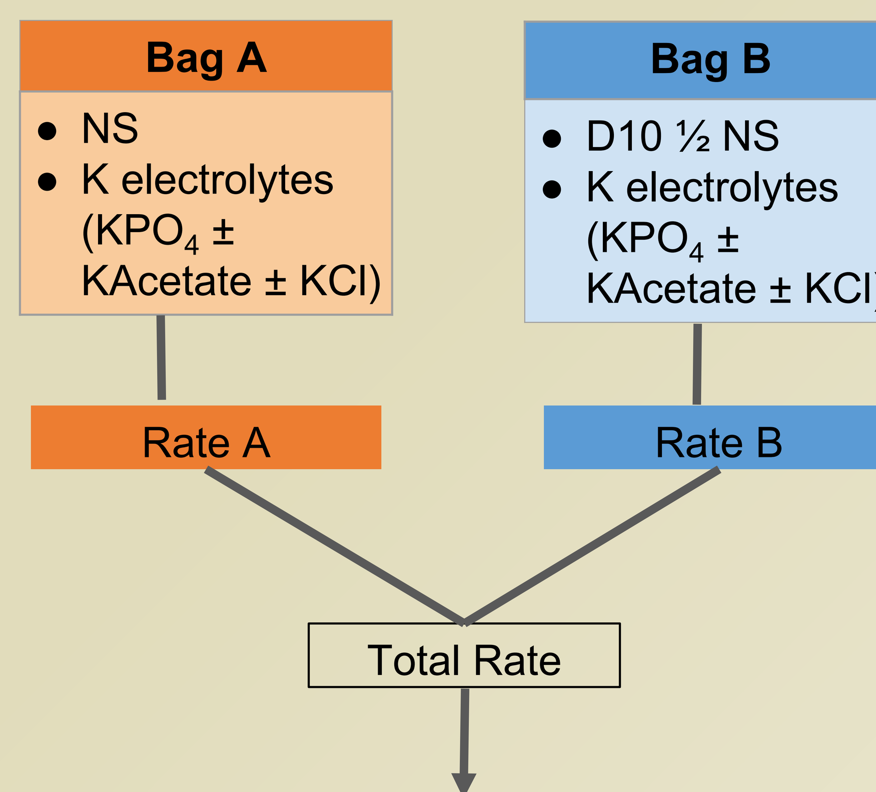

Table 2. Primary and Secondary Endpoints

	1 bag system (n=24)	2 bag system (n=22)	P value
Time to resolution of acidosis (hr)	7.8 (0.4-23.19)	8.6 (4.4-18.5)	0.69
Time to transition to SC insulin (hr)	13 (4.4-22.4)	12.9 (3.5-20.1)	0.98
Number of wasted IV fluid bags	1 (0-4)	0 (0-2)	0.55
Duration of ICU stay (hr)	11.2	12.2	0.69
Symptoms of cerebral edema	5	8	0.33
Number of insulin rate changes	2.4	1.7	0.31

Table 3. CHOC's two bag system DKA care guideline. Percentage of Dextrose and NS in each bag are based on blood glucose concentration. Total rate depends on fluid needs.

		Bag A	Bag B
	Plasma glucose (mg/dL)	NS	D10 ½ NS
Phase 1	>300	100%	0%
Phase 2	225-300	50%	50%
Phase 3	150-224	25%	75%
Phase 4	100-149	0%	100$
	<100	Change to D12.5 with ½ NS + K and hold insulin drip for 30 min until BG >150 mg/dL	

CONCLUSION

- Although nonsignificant, the time to transition to SC insulin and number bag IV fluid bags wasted were less in the 2 bag system, which can provide an economic benefit.
- This study shows that the 2 bag system decreases the number of times the insulin rate had to be adjusted. The ability to readily adjust the dextrose concentration with the 2 bag system provided the ability to maintain the insulin drip rate.
- In congruent to other studies, our study also found no difference in time to resolution of acidosis.
- Symptoms of cerebral edema, defined by presence of headache, confusion, hallucination, altered mental status, or administration of mannitol or hypertonic saline were evaluated due to its high risk of morbidity and mortality
- Our study has some limitations. Our data relied on accurate timing and charting to be recorded by the nursing staff and physicians.
- In conclusion, using the 2 bag system in management of pediatrics DKA did not change time to bicarbonate resolution. A larger population size and cost analysis of the 2 groups could further show benefits and efficiency of the 2 bag system.

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