Management of paediatric diabetic ketoacidosis : a retrospective study

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Background

- Diabetic ketoacidosis (DKA) is a major and common complication associated with a significant morbidity and mortality in children with diabetes.
- Following the Canadian Diabetes Association (CDA) guidelines, our tertiary care paediatric hospital was provided a DKA management protocol in 2009.

Objectives

Primary: Assess the proportion of DKA cases that are marked by non-adherence to our DKA management protocol.

Definition : Non-adherence was arbitrarily defined as the occurrence of ≥1 major deviation and/or ≥2 minor deviations to the protocol during the acute management of DKA.

Secondary:
Describe the prevalence of complications
- Electrolytes disturbances
- Hyperchloremic acidosis
- Cerebral edema

Methods

- Retrospective study by chart review, using a standardized data entry form
- Inclusion :
  - Age < 18 years,
  - Pediatric ICU admission in our hospital between March 2009 and September 2013
- Exclusion :
  - Non-type I diabetes
  - Principal diagnosis at presentation other than DKA

Hypothesis

Actual clinical practice of physicians in our hospital may not always correspond to our protocol recommendations.

Results

- 73 patients included; demographic and clinical data (table 1)
- Protocol deviations and non-adherence (table 2)
  - 51% patients' management was marked by ≥ 1 major deviation, mostly:
    - Failure to monitor hourly neurological status
    - Inappropriate administration of 0,9%NaCl IV bolus in well-hydrated patients
  - 90% patient's management was marked by ≥ 2 minor deviations, mostly:
    - Failure to monitor urine ketones level every 4 hours
    - Failure to monitor blood gas and serum electrolytes every 2 hours
  - Overall, non-adherence to DKA protocol occurred in 95% of cases.
- Complications and evolution (table 3)
  - Rare hypoglycemic episodes and clinically suspected cerebral edema
  - 75% cases of hyperchloremic acidosis (HA):
    - Mean time apparition: 4h41 after insulin perfusion beginning, using a normal anion gap definition of ≤14 (figure 1)
    - Perfusion insulin time in patients without HA : 9.2+/-5.6 hours; in patients with HA 17.1+/-9.1 hours (p<0,002)

Table 1

Demographic and clinical data

Age (y)	9.7 (5.0)
Female sex	42 (53.2)
Weight (kg)	33.9 (18.1)
New-onset diabetes	60 (75.9)
Antecedent of previous DKA	11 (13.9)
Insulin administration (in known diabetic patients)	
· Multiple injections	12 (63.2)
· Insulin pump	7 (36.8)
Severity of DKA	
· Mild	24 (30.4)
· Moderate	30 (38.0)
· Severe	25 (31.6)
Identified precipitating factor (in known diabetic patients)	
· Infection	1 (1.3)
· Poorly controlled diabetes	3 (3.8)
· Insulin pump dysfunction	4 (5.1)
· Omission of insulin (voluntary or not)	10 (12.7)

Date are expressed as mean(SD) or number(%)

Table 2

Protocol deviations and non-adherence

Major deviations	
Administration of IV fluid bolus in a well-hydrated patient	5 (6.8)
Use of IV fluid other than saline 0,9% for initial rehydration	7 (12.7)
Rate of maintenance IV fluids > 2 times maintenance fluid requirements	4 (5.5)
Administration of IV insulin bolus	3 (4.1)
Initial insulin IV infusion rate > 0,1 U/kg/h	1 (1.4)
Administration of bicarbonates bolus without indication	0
Failure to monitor neurologic signs every hour in at least two occasions in the first 12 hours of acute management*	32 (46.4)
Total ≥ 1 major deviation	37 (50.7)
Minor deviations	
Failure to monitor blood glucose every hour in ≥ 2 occasions **	21(29.2)
Failure to monitor blood gas every 2 hours	33 (45.2)
Failure to monitor serum electrolytes every 2 hours	33 (45.2)
Failure to monitor BUN level every 4 hours	31 (42.5)
Failure to monitor urine ketones level every 4 hours	66 (90.4)
Failure to monitor serum calcium level every 4 hours	13 (17.8)
Failure to add 5% dextrose to IV fluid when blood glucose drops < 17 mmol/L	9 (12.3)
Failure to add 10% dextrose to IV fluid when blood glucose drops < 11 mmol/L	9 (12.3)
Failure to add KCl to IV fluid if serum potassium levels ≤ 5,0 mmol/L *	24 (33.3)
Failure to add K_2PO_4 to IV fluid if supplementation in KCl > 40 mEq/L or if serum potatssium level < 3,5 mmol/L	3/25 (12)
Total ≥ 2 minor deviations	66 (90.4)
Non-adherence	69 (94.5)

Date are expressed as number(%)
*: 4 missing values; **: 1 missing value
Non-adherence was defined as the occurrence of ≥1 major deviation and/or ≥2 minor deviations to the protocol during the acute management of DKA.

Table 3

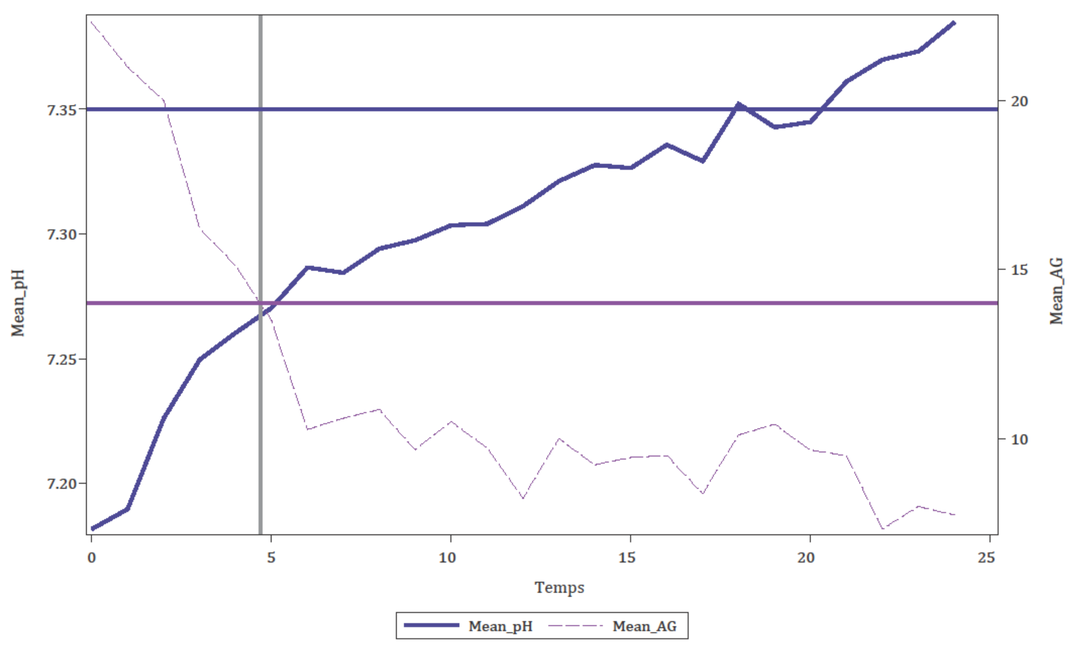
Complications

Hypoglycaemia	2 (3)
Hyperchloremic acidosis	55 (75.3)
Cerebral edema	
Clinically suspected	4(5.5)
Radiologically suspected	1(1.4)
Death	0
Insulin perfusion length (h)	15.3(9)

Date are expressed as mean(SD) or number(%)

Figure 1

Anion gap and pH evolution during insulin perfusion



Discussion

- More education is needed about the importance of monitoring neurological status hourly and not giving overly generous intravenous hydration.
- Relevance to monitor ketonuria:
  - No mention in CDA guidelines recommandations.
  - ISPAD does not see the usefulness of urine ketones to determine when to stop the insulin infusion.
- Despite poor adherence demonstrated by our study, the number of complications observed did not exceed the complication rate expected.
- Frequently observed hyperchloremic acidosis
  - Probably related to prolonged use of NS
  - Extends the use of the IV fluids, insulin and probably ICU length of stay.

Conclusion

- Non-adherence to our DKA management protocol was observed in majority of cases for minor deviations.
- The establishment of a protocol does not guarantee its adherence and surveillance of its application is needed.
- More studies have to be done to understand clinical impact of hyperchloremic acidosis.

References

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Diabetes 1

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