Evaluation of Diabetic Ketoacidosis Treatment at a Tertiary Acute-Care Hospital

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Background

- Diabetic ketoacidosis (DKA) is a diabetic emergency characterized by metabolic acidosis, ketonemia and typically hyperglycemia.
- As per Diabetes Canada, timely IV fluids and an insulin infusion are required to correct DKA-induced metabolic derangements.
- Frequent monitoring to optimize DKA treatment may be difficult in the high volume/acuity of the Surrey Memorial Hospital (SMH) emergency department.
- DKA treatment protocols have been associated with increased guideline-concordant treatment and a reduction of associated adverse events (hypokalemia, hypoglycemia). At the time of this review, there was no protocol available for the treatment of DKA at SMH.
- **Purpose of study:** To describe the management of DKA at SMH and identify potential focus areas for improvement.

Study Definitions

- **DKA:** diagnosis by physician AND pH ≤ 7.3 AND presence of ketones in serum or urine AND anion gap (AG) > 12 mmol/L.
- **Resolution of DKA :** AG ≤ 12 mmol/L and serum bicarbonate ≥ 15 mmol/L.
- **Diagnostic biochemical markers:** baseline blood glucose, CBC, CHEM-7, ketones, calcium, phosphate, magnesium, osmolality.
- **Appropriate potassium therapy:** 10-40 mmol/L potassium given when potassium is > 3.3 mmol/L, but < 5-5.5mmol/L.
- **Hypoglycemia:** blood glucose < 4 mmol/L.
- **Hypokalemia:** potassium < 3.5 mmol/L.
- **Instance of follow-up bloodwork**: time point where ≥1 of the following was drawn: AG, potassium, bicarbonate.

Objectives

- **Primary:** To describe management of DKA at SMH by determining:
  - Time from triage to initiation of insulin infusion.
  - Time to resolution of DKA.
- **Secondary:** To describe management of DKA at SMH by reporting on multiple efficacy and safety parameters (fluid resuscitation, hypoglycemia, hypokalemia, follow-up bloodwork).

Methods

- **Design:** retrospective chart review of adult patients admitted to SMH July 2018-July 2019.
- **Inclusion criteria:** patients with primary or secondary diagnoses of DKA.
- **Exclusion criteria:** patients admitted directly to critical care, pregnant patients, patients with starvation or alcoholic ketoacidosis.
- **Statistics:** convenience sample in reverse chronological order, descriptive statistics.

Results

Table 1: Patient Characteristics (N=92)

Age, median (IQR)	45 (25.8 - 58.3)
Male sex, no (%)	62 (67.4)
Precipitating factor, no (%)	
Med non-compliance	34 (37.4)
Infection	25 (27.5)
Other	33 (35.2)
Diabetes Type, no (%)	
Type 1	41 (44.6)
Type 2	51 (55.4)
Presence of comorbidities, no (%)	
CHF	3 (3.3)
Renal failure (AKI and/or CKD)	29 (31.5)
COPD	1 (1.1)
Baseline labs, median (IQR)	
pH	7.23 (7.13 - 7.27)
Anion gap (mmol/L)	31 (25 - 37)
Bicarbonate (mmol/L)	11.5 (7.8 - 15.3)
Beta-hydroxybutyrate (mmol/L)	6.7 (5.3 - 8.7)
Blood glucose (mmol/L)	30 (21.5 - 40.8)
Presence of euglycemic DKA, no (%)	2 (2.2)
Median length of stay in hospital, hours (IQR)	96 (48 - 168)
All-cause in-hospital mortality, no (%)	2 (2.2)

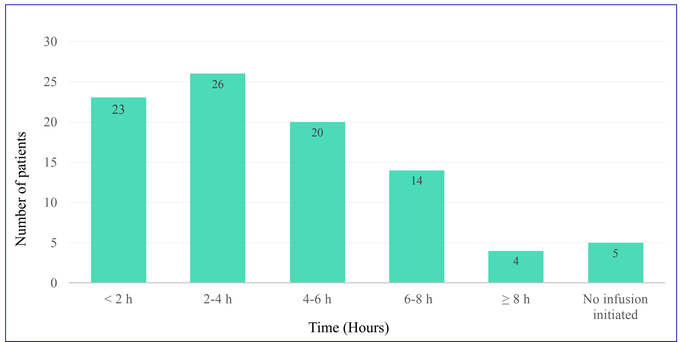

Figure 1: Time from triage to initiation of insulin infusion therapy (N = 92)

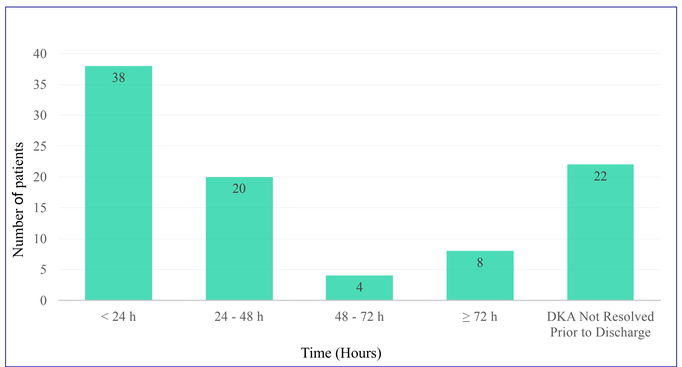

Figure 2: Time to DKA resolution (N = 92)

Table 2: Efficacy parameters of patients receiving insulin infusion (N = 87)

Outcome	Result
Diagnostic biochemical markers within 1 hour of triage in ED, n (%)	78 (89.7)
Time from triage to initial fluid resuscitation, minutes, median (IQR)	53 (26.3 - 122.3)
Volume of fluid resuscitation prior to insulin initiation, mL, median (IQR)	2000 (1000 - 2000)
Appropriate potassium therapy within first 4 hours of insulin infusion, no (%)	55 (62.5)
Insulin infusion stopped prior to DKA resolution, n (%) *(n = 85)*	47 (54.7)

Table 3: Safety parameters of patients receiving insulin infusion (N = 87)

Outcome	Result
Hypoglycemia requiring holding of insulin infusion, no (%)	8 (9.2)
Hypokalemia during DKA treatment, n (%)	33 (37.9)
Insulin infusion not held when potassium < 3.3 mmol/L, no (%)	8 (9.2)
Instances of bloodwork in the first 24 hours of treatment, median (IQR)	7 (6 - 8)
Escalation to critical care, n (%)	4 (4.6)
Re-opening of anion gap (AG > 12 mmol/L), n (%) *(n = 70)*	48 (68.6)

Discussion

- Majority of patients had bloodwork drawn within 1 hour of triage, but time to result(s) availability was not assessed. 47% of patients experienced a > 4 hour delay in initiation of IV insulin.
- Large proportion of patients did not experience DKA resolution prior to discharge.
  - Fraser Health lab reports AG normal reference range: 3-16 mmol/L
  - 12 pts (13%) had AG 13-16 mmol/L at cessation of insulin infusion
- Monitoring of potassium occurred approx. every 3 hours (per guidelines). 40% of patients did not receive supplementation when serum potassium was < 5 - 5.5 mmol/L, as recommended by Diabetes Canada guidelines.
- **Study limitations:**
  - Retrospective review precludes determination of reasons for delays in therapy.
  - Exclusion of patients who otherwise met DKA criteria, but were not acidotic due to a secondary process or underlying condition.

Conclusions

- Significant variation in DKA treatment was observed.
- A pre-printed order for DKA treatment was recently developed for Fraser Health. Further investigation is required to determine if this intervention will standardize DKA care and improve patient outcomes.
- A potential area for future research is the reassessment of DKA treatment at SMH post-implementation of the DKA pre-printed order.