Evaluation of Computer-Based Insulin Titration on ICU Length of Stay in Diabetic Ketoacidosis

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UNC HEALTH

BACKGROUND

- Continuous intravenous (IV) insulin infusions, IV fluid resuscitation, and correction of electrolyte derangements are the cornerstones of therapy for Diabetic Ketoacidosis (DKA).

- Given the serious risk of hypoglycemia and metabolic abnormalities associated with continuous IV insulin infusions, patients with DKA are often admitted to the intensive care unit (ICU) for management of therapy. IV insulin infusions are frequently managed by algorithm-based titrations that fail to incorporate patient-specific factors and are prone to human error which can impact both the efficacy and safety of IV insulin therapy.

- An alternative to algorithm-based insulin management is computerized decision support software (CDSS), which aims to provide more precise blood glucose management to increase the safety and efficacy of DKA therapy by providing recommendations for IV insulin management based on patient-specific factors.

- CDSS guided IV insulin infusion management is associated with faster resolution of DKA and fewer hypoglycemic events compared to algorithm-based management.[1-2]

PURPOSE

To determine whether CDSS guided IV insulin infusion management changes the total duration of IV insulin infusion therapy in the ICU compared to an algorithm-based approach.

METHODS

Design
- Single-center, retrospective review

Patient Population
- Inclusion Criteria: clinical diagnosis of DKA, admitted to medicine ICU
- Exclusion Criteria: received IV insulin at an outside hospital prior to arrival, Group 2 <75% of total time on insulin infusion in medicine ICU

Patient Cohorts
- Group 1: Continuous IV insulin via standard algorithm (n=130) April 1, 2014 – August 31, 2017
- Group 2: Continuous IV insulin via CDSS (n=130) October 1, 2017 – May 30, 3030

References:
1. Ullal J, Aloi JA, Reyes-Umpierrez D, Pasqel FJ, et al. Comparison of computer-guided versus standard insulin infusion regimens in patients with diabetic ketoacidosis. Journal of Diabetes Science and Technology. 2018;12(1):39-46.
2. Younis M, Pham J, Asad H, et al. Computer-based versus paper-based insulin infusion algorithms in diabetic ketoacidosis. Current Diabetes Review. [abstract]. 2019.

OUTCOMES

Primary outcome

- Mean time (hours) spent on continuous IV insulin infusion in the ICU

Secondary outcomes

- Time (hours) to anion gap closure form start of IV insulin infusion
- Time(hours) from initiation of IV insulin infusion to subcutaneous insulin
- Frequency of hypoglycemia (BG<70 mg/dL)
- In-hospital mortality
- ICU length of stay (days)
- Hospital length of stay (hours)

DEMOGRAPHICS

Table 1. Baseline Characteristics	Group 1 (n=130)	Group 2 (n=130)
Mean age (years)	43	42
Male, n (%)	70 (53.8)	63 (48.5)
Mean blood glucose (mg/dL)	340	349
Mean anion gap (mmol/L)	18	19
Mean pH	7.25	7.28
Mean hemoglobin A1c (%)	11.8	10.8
DKA Etiology		
Sepsis, n (%)	24 (18.5)	26 (20.0)
Documented infection, n (%)	45 (34.6)	47 (36.2)
Medication non-compliance, n (%)	61 (46.9)	54 (41.5)
Comorbidities		
Type 1 Diabetes Mellitus, n (%)	80 (61.5)	69 (53.1)
Hypertension, n (%)	64 (49.2)	73 (56.2)
Chronic Kidney Disease, n (%)	33 (25.4)	46 (35.4)

RESULTS

Table 2. Primary Outcome	Group 1 (n=130)	Group 2 (n=130)	*P*-value
Mean hours in medicine ICU on insulin infusion (SD)	21.58 (16.01)	23.54 (20.58)	0.44

Table 3. Secondary Outcomes	Group 1 (n=130)	Group 2 (n=130)	*P*-value
Mean hours in ED on insulin infusion (SD)	1.85 (2.35)	1.33 (1.63)	0.20
Mean total hours on insulin infusion (SD)	23.45 (15.91)	24.87 (21.13)	0.87
Mean hours to anion gap closure (SD)	10.47 (14.41)	13.60 (23.97)	0.11
Mean hours to transition to subcutaneous insulin (SD)	22.93 (16.07)	24.41 (21.11)	0.84
Mean days in the ICU (SD)	2.47 (3.68)	2.57 (2.43)	0.15
Mean days in the hospital (SD)	5.74 (8.90)	6.79 (11.07)	0.39
Mean hours in the ED (SD)	4.28 (2.97)	5.08 (3.95)	0.21
Mean units of IV insulin received (SD)	79 (67.76)	134 (4.30)	<0.01
Mean hypoglycemic events per patient (SD)	0.1308 (0.42)	0.0308 (0.18)	0.01
In-hospital mortality, n (%)	4 (3.1)	5 (3.8)	0.73

CONCLUSIONS/FUTURE DIRECTIONS

- Duration of IV insulin infusion in the medicine ICU was not significantly different between algorithm-based and CDSS guided management.

- However, CDSS guided IV insulin infusion management was associated with a significantly lower incidence of hypoglycemic events.

- Limitations of this study include the retrospective design, time bias between patients receiving IV insulin via an algorithm versus CDSS guided approach, lack of patient-oriented primary outcome, and inability to assess potential confounding variables such as appropriate management of other comorbidities and specific IV fluids used for resuscitation and glycemic management.

- A larger prospective study aiming to assess efficacy and safety of CDSS-based continuous IV insulin infusions compared to algorithm guided insulin therapy with a patient-centered primary outcome is needed to validate these findings.