Evaluation of Compliance to an Intravenous Insulin Infusion Protocol in the Management of Diabetic Ketoacidosis

Beaumont

Whitney Aultman, Pharm.D., Maxine Ng, Pharm.D., BCPS, Rashmi Dungarani, Pharm.D., Afomia Feleke, Pharm.D., BCPS

Department of Pharmaceutical Services ▪ Beaumont Hospital – Royal Oak, MI

accp American College of Clinical Pharmacy

INTRODUCTION

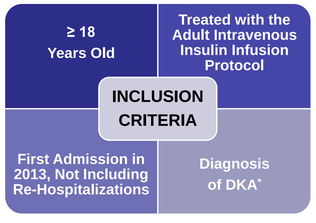
- Diabetic ketoacidosis (DKA) is a hyperglycemic emergency that can be fatal, if left untreated. The American Diabetes Association (ADA) Consensus Guidelines outline the treatment recommendations for the management of DKA, stressing the importance of fluid management, electrolyte replacement and insulin therapy.[1,2]
- Previous studies have shown that an intravenous (IV) insulin infusion nomogram can reduce errors and improve glycemic control without increasing incidence of hypoglycemia. Ideally, the insulin infusion should result in a steady decline of the blood glucose (BG) by 50 to 75 mg/dL per hour, which is considered optimal.[3-5]
- Our institution recently (September 2012) implemented a paper-based, fixed-dose insulin infusion protocol targeting a BG range of 140–180 mg/dL for the management of hyperglycemia, including DKA. This protocol is permitted for use on regular medical/surgical floors as well as intensive care units.

OBJECTIVE

To assess compliance with a paper-based, fixed-dose, IV insulin infusion protocol as well as its safety and efficacy in managing hyperglycemia due to DKA

METHODS

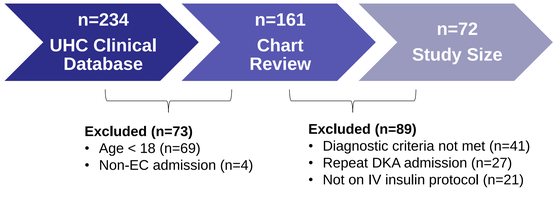
- Single-center retrospective chart review of DKA patients admitted through the emergency center (EC) from January 2013 - December 2013
- Institutional Review Board (IRB) approved
- Patients were identified through the University Health-System Consortium (UHC) Clinical Database



*** Diagnosis of DKA Defined as[6-10]:**

- BG > 250 mg/dL
- Anion gap > 10
- Bicarbonate level ≤ 18 mEq/dL, and
- Arterial/venous pH ≤ 7.3
  - If pH was not checked, a positive serum beta-hydroxybutyrate level (>3 mmol/L) was used as the fourth diagnostic criteria

***Figure 1.** Determination of Patient Sample Size*



DATA ANALYSIS

- Descriptive statistics were utilized to analyze baseline demographics and endpoints

ENDPOINTS

Primary Endpoint: Assess Compliance

- Protocol compliance, defined as correct adjustment of IV insulin infusion rate and correct timing of BG checks ± 20 minutes from the time frame stated in the protocol

Secondary Endpoints: Evaluate Protocol Efficacy

- Time to appropriate BG range (70-180 mg/dL)
- Average BG
- BG measurements within appropriate range (70-180 mg/dL)
- BG measurements within protocol target (140-180 mg/dL)

Safety Endpoints:

- Hypoglycemia: BG < 70 mg/dL
- Severe Hypoglycemia: BG < 40 mg/dL
- Hyperglycemia: BG > 180 mg/dL
- Hypokalemia: K^+ < 3.3 mEq/L

DATA COLLECTION

Patient Demographics	Insulin Infusion Data	BG Data	Potassium Data
• Locations of insulin infusion • Age • Sex • Weight • Height • BMI • Hgb A1c • Type of diabetes mellitus • Duration of diabetes diagnosis • DKA diagnostic measures	• All insulin infusion rates • Timing of insulin infusion rates • Compliance or non-compliance of chosen rate to that stated in insulin infusion protocol	• All BG values during insulin infusion • Time of BG collections • Compliance or non-compliance of BG timing to that stated in insulin infusion protocol	• K^+ values collected during insulin infusion • Hypokalemic events

RESULTS

***Table 1.** Patient Population Baseline Characteristics*

Demographics (n=72)	
Age (years), mean ± SD	40.4 ± 19.5
Male, no. (%)	32 (44.4)
Weight (kg), mean ± SD	73.5 ± 20.2
BMI (unit), mean ± SD	25.5 ± 7.3
Hgb A1c, mean ± SD	11.8 ± 2.3
Type 1 DM, no. (%)	46 (64.8)
DKA Diagnostic Criteria (n=72)	
BG (mg/dL) at admission, median (range)	492 (302 - 1326)
HCO^{3-} (mEq/L), mean ± SD	10.9 ± 4.3
Anion gap, mean ± SD	21.4 ± 5.6
pH, mean ± SD; n=65	7.1 ± 0.18
Beta hydroxybutyrate, mean ± SD; n=66	8.4 ± 3.6

***Table 2.** Primary Outcome: Protocol Compliance*

Total BG Measurements (n=1825)	
Overall compliance, no. (%)	1016 (55.6)
Correct timing of BG measurements ± 20 minutes, mean % ± SD	75 ± 0.16
Early, no. (%)	104 (5.7)
On time, no. (%)	1353 (74)
Late, no. (%)	371 (20.3)
Correct insulin infusion rate per protocol, no. (%)	1357 (73.7)

***Table 3.** Secondary and Safety Outcomes of the Protocol*

Patient Population (n=72)	
Total length of IV insulin therapy in hours, mean ± SD	28.6 ± 18.76
Time to appropriate BG range (70-180mg/dL) in hours, mean ± SD	7.2 ± 6.7
Number of BG measurements during insulin infusion, mean ± SD	25 ± 13.82
BG Measurements After First BG < 180mg/dL (n=1432)	
BG measurements within appropriate range of 70-180mg/dL, no. (%)	926 (64.7)
BG measurements within protocol target range of 140-180mg/dL, no. (%)	433 (30.2)
Average BG, mean ± SD	167 ± 66.74
Incidence of hyperglycemia (BG > 180mg/dL), no. (%)	463 (32.3)
Incidence of hypoglycemia (BG <70mg/dL), no. (%) Number of continuous hypoglycemic measurements (episodes)	34 (0.24) 24
Number of patients experiencing hypoglycemia, no. (%) Patients experiencing severe hypoglycemia (BG < 40mg/L), no. (%)	20 (27.8) 2 (2.8%)

***Table 4.** Potassium Data*

Total Potassium (K^+) measurements, n=66	400
Patients without Potassium (K^+) data, no.	6
Incidence of hypokalemia, no. (%)	40 (10)
Number of patients experiencing hypokalemia, no. (%)	19 (28.8)

CONCLUSIONS

- There was a high level of compliance to individual protocol variables of correct BG timing (75%) and correct insulin infusion rate (74%)
  - When BG collection timing was non-compliant, more likely due to late collection (20.3%)
- There was a low level of compliance to both variables (56%), which could be reflected in the finding that BG values were in the appropriate BG range only 64.7% of the time

LIMITATIONS

- Single hospital site retrospective chart review
- Relying on accurate documentation of insulin infusion
- Inability to assess clinical judgment leading to protocol deviation
- Variable number of BG collections per patient

FUTURE IMPLICATIONS

- Educational opportunities on protocol use and management of hyperglycemia/ hypoglycemia
- DKA-Specific Order Set
  - Required labs (baseline and monitoring)
  - IV fluid therapy and electrolyte replacement
  - Insulin infusion therapy
    - Conversion to weight-based insulin initiation and maintenance protocols
    - Target BG 150-200 mg/dL per ADA guidelines
  - Hourly reminders to nursing staff for BG checks

DISCLOSURE

Authors of this presentation have nothing to disclose concerning possible financial or personal relationships with commercial entities that may have a direct or indirect interest in the subject matter of this presentation

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