Innovative Algorithm for Dosing Prandial Insulin in Patients with Diabetes Undergoing Hemodialysis

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Problem Identification

Background
Patients with diabetes undergoing hemodialysis (HD) have unpredictable oral intake due to uremic symptoms and hemodynamic changes. Previously HD nurses administered prandial insulin doses with no consideration for the amount of carbohydrate (CHO) consumed. Hypoglycemia was common, especially after prandial insulin dosing. Currently, there is no prandial insulin dosing guideline that considers both current blood glucose (BG) and the amount of CHO consumed for patients with diabetes undergoing HD.

Clinical Question
Population – Inpatients with diabetes undergoing HD in an acute HD unit receiving a meal tray
Intervention – Administration of prescribed prandial insulin with consideration for current BG and amount of CHO consumed ($\geq 30\text{g}$ CHO)
Comparison – Administer prescribed prandial insulin based on current BG only
Outcome – Target range of BG (140–180 mg/dL or 7.8–10.0 mmol/L)

Evidence Review

Insulin requirements decrease as renal function declines.^{1,3}
The kidney clears and degrades up to 25% of endogenous insulin. Decreased insulin catabolism overrides insulin resistance. Impaired degradation of insulin contributes to insulin’s prolonged half-life. Insulin requirements are often reduced by 50% in end stage renal disease (ESRD).

Dialysates affect blood glucose.¹
Most dialysate solutions contain 100 mg/dL or 5.6 mmol/L of glucose. Glucose diffuses easily between blood and dialysate solutions. Patients with hyperglycemia may have BG levels lowered by HD.

Less stringent A1C goal for ESRD/HD patients
• ADA (2019) standards of care: A1C $< 8\%$ (BG 183 mg/dL or 10.2 mmol/L) for patients with a history of advanced microvascular complications²
• KDOQI (2012) diabetes guidelines: A1C $> 7\%$ (BG 154 mg/dL or 8.6 mmol/L) for ESRD patients treated with insulin⁵
• A study of 23,296 Canadian patients GFR < 60 ml/min (2011): No significant increase in mortality at A1C 7.5–8.4% (BG 169–194 mg/dL or 9.4–10.8 mmol/L)⁶

Hypoglycemia alert value is a BG ≤ 70 mg/dL or 3.9 mmol/L and clinically significant hypoglycemia is BG < 54 mg/dL or 3 mmol/L.²
• Treatment: 15g–25g CHO until BG > 80 mg/dL or 4.4 mmol/L²
• Based on above references, we hypothesized;
1. 15–25 grams CHO expected to raise BG 10–30 mg/dL or 0.6–1.7 mmol/L.
2. 30 grams CHO presumably raise BG by 20–60 mg/dL or 1.1–3.3 mmol/L.

Reference
1. Abe, M., & Kalantar-Zadeh, K. (2015) Haemodialysis-induced hypoglycemia and glycaemic disarrays. Nature Review Nephrology, 11(5), 302–313 2. American Diabetes Association (2019) Diabetes Care in the Hospital: Standards of Medical Care in Diabetes -2019, Diabetes Care, 42 (Supplement.1), S61–S70 3. Lyengar, R., Franzese, J., Gianchandani, R.(2018) Inpatient Glycemic Management in the Setting of Renal Insufficiency/Failure/Dialysis. Current Diabetes Reports, 18:75 4. Nakato, T., Inaba, M., Abe, M., Kaizu, K., Shima, K., Babazono, B., Akizawa, T. (2015) Best Practice for Diabetic Patients on Hemodialysis 2012, Therapeutic Apheresis and Dialysis, 19, 40–66 5. National Kidney Foundation (2012) Kidney Disease Outcomes Quality Initiative (KDOQI) Clinical Practice Guideline for Diabetes and CKD: 2012 Update. American Journal of Kidney Disease, 60(5), 861–864. 6. Rhee, C.M., Leung, A.M., Kovesdy, C.P., Lynch, K.E., Brent, G.A., & Kalantar-Zadeh, K. (2014) Updates on the Management of Diabetes in Dialysis Patients, Seminars Dialysis, 27(2),135–145.

New Algorithm

- June 2016 – present
- Algorithm tested for face validity by departments of Nephrology, Endocrinology, Nursing, and Nutrition
- Unanimous agreement - it is safe and may lead to improved outcomes.
- Monitoring HD nurses compliance to algorithm monthly

Research

- Design - retrospective study in 2017
- Methods - compared pre-post rates of hypoglycemia events using new algorithm
- Results - no significant difference (28.6% vs 22.5%, chi square test) in rates of hypoglycemia
- Limitation - small sample size (n=47), intervention fidelity issues with algorithm-adherence, and our study design limiting causality

Next Step

- The algorithm can be safely maintained until efficacy is ascertained by the prospective study in 2020.