

Evaluation of Hypoglycemic Events and Complications in Treating Diabetic Ketoacidosis and Hyperosmolar Hyperglycemic Syndrome for Patients with Impaired Renal Function

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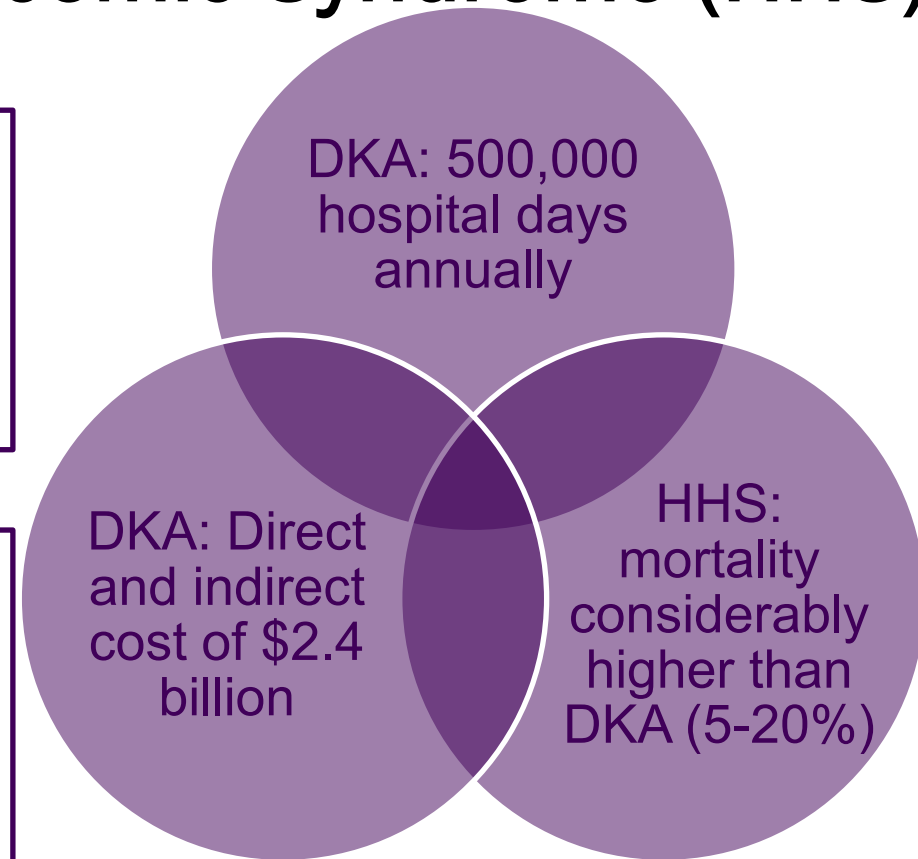
Diabetic Ketoacidosis (DKA) and Hyperosmolar Hyperglycemic Syndrome (HHS)

DKA

- Uncontrolled hyperglycemia
- Metabolic acidosis
- Increased total body ketone concentration

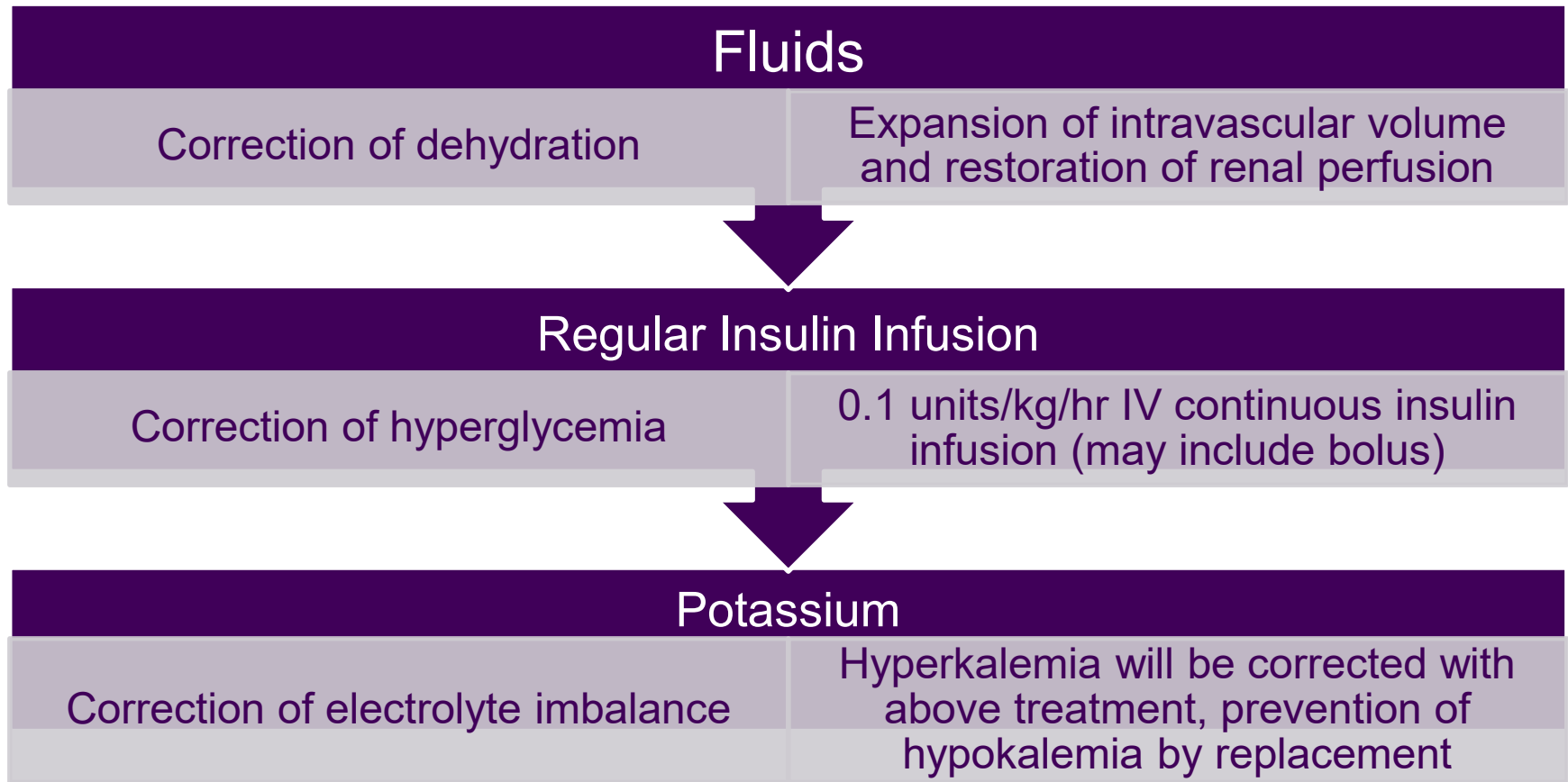
HHS

- Severe hyperglycemia
- Hyperosmolality
- Dehydration in the absence of significant ketoacidosis



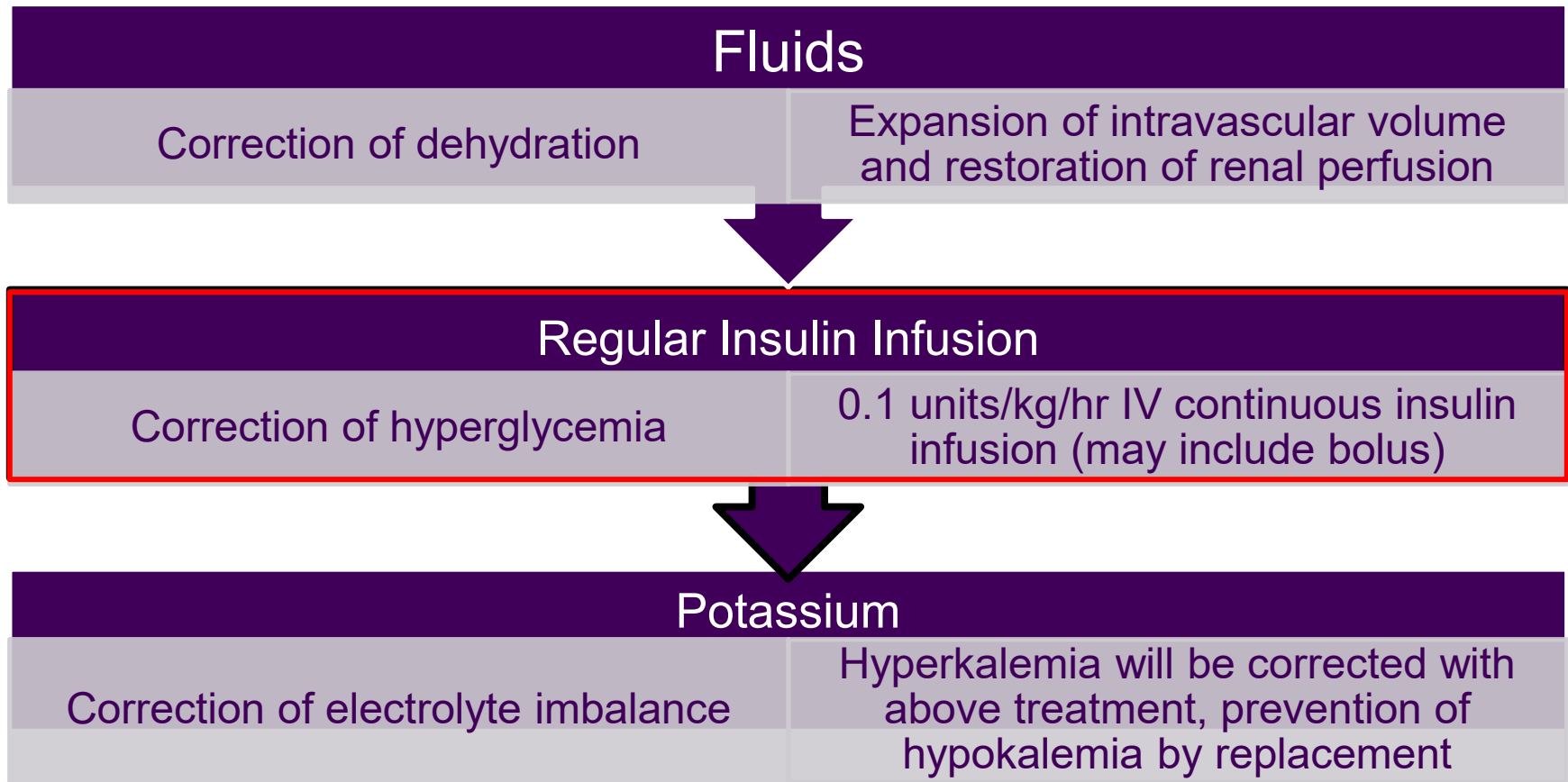
Diabetes Care. 2009;32(7):1335-43.

Treatment of DKA and HHS



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Treatment of DKA and HHS



Diabetes Care. 2009;32(7):1335-43.

Complications of Treatment with Insulin IV Continuous Infusion

Hypoglycemia

Hypokalemia

Diabetes Care. 2009;32(7):1335-43.

Current Literature: Schaapveld-Davis, et al

Groups: Both with DKA/HHS

- ESRD (chronic HD x 3 months)
- Normal renal function (eGFR \geq 60 mL/min/1.73m²)

Primary Outcome: Adverse Glucose Events (AGEs)

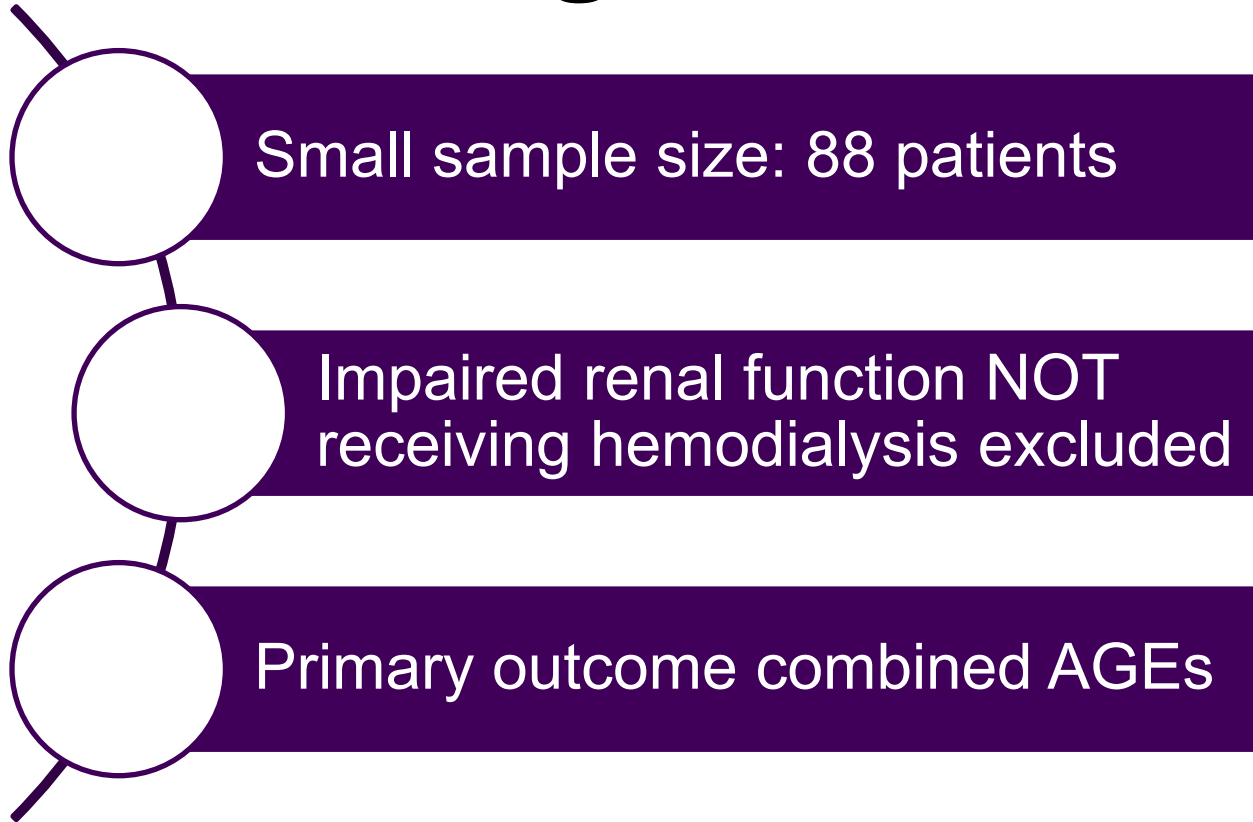
- BG < 70 mg/dL
- BG decrease > 200 mg/dL in a 1-hour period

Results

- Experienced \geq 1 AGEs: P < 0.0005
- Hospital length of stay: P = 0.029

Clin Diabetes. 2017;35(4):202-208.

Limitations Requiring Further Investigation



Clin Diabetes. 2017;35(4):202-208

Study Objective & Hypothesis

Objective

- To determine if renal function impacts the incidence of hypoglycemia

Null Hypothesis

- No difference in hypoglycemic events between patients with normal renal function (eGFR \geq 60 mL/min) compared to patients with impaired renal function (eGFR $<$ 60 mL/min)

Study Definitions

DKA and HHS

- ICD-10 codes to identify patients based on diagnosis (confirmed by chart review)

Hypoglycemic Event

- Blood glucose < 70 mg/dL

Chronic Kidney Disease

- KDIGO classifications for stages of kidney disease (i.e. based on eGFR; Stages IIIa/IIIb, IV, and V)

Diabetes Care. 2005;28(5):1245-9.
Kidney Int. 2005;67(6):2089-100.

Study Design

Retrospective

Cohorts: Normal renal function vs. Impaired renal function

Medical record review

Epic[®] system

Study Methods

Inclusion Criteria

Adults \geq 18 years of age	Admitted to Mercy Hospital St. Louis from 9/18/2018 to 6/30/2019	Received IV insulin drip continuously for a minimum of 1 hour for the treatment of DKA/HHS
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Exclusion Criteria

Pregnancy	Withdrawal of care within 24 hours of hospitalization or transferred from an outside facility	Cardio-thoracic Surgery Unit
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Study Outcomes

Primary Outcome

- Absolute difference in the incidence rate of hypoglycemia between groups

Subgroup Analyses of Primary Outcome

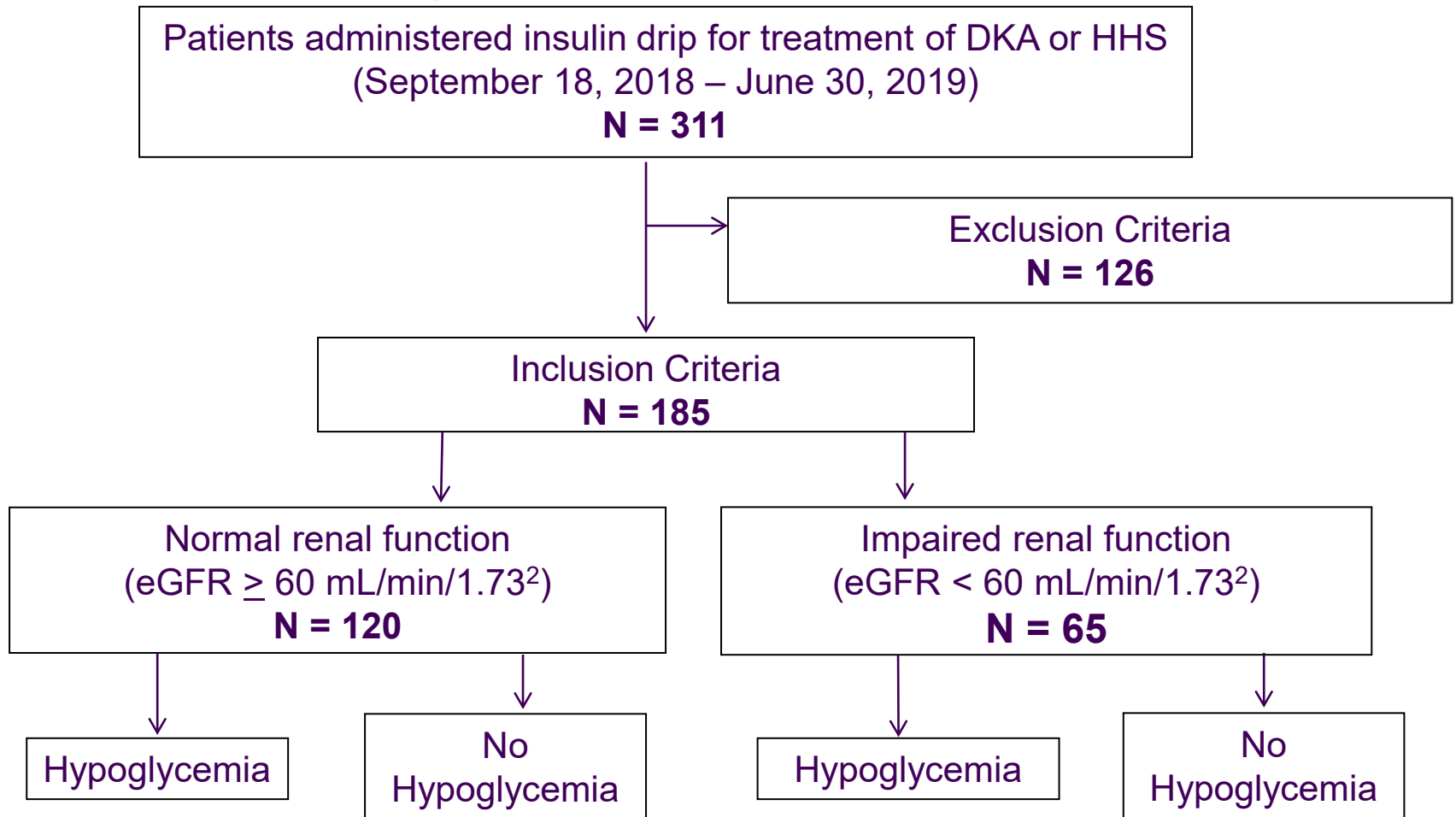
- Age \geq 65 years
- T1DM vs T2DM
- Nephrology or Endocrine Consult

Study Outcomes

Secondary Outcomes

- Hypoglycemia: normal renal function compared to each Stage of CKD (IIIa/IIIb, IV, and V)
- Hyper- or hypokalemia
- Decrease of BG > 200 mg/dL (1-hour period)
- Length of stay (Hospital and ICU)
- Mortality

Flow Diagram of Patient Selection



Statistical Analysis

Primary outcome
and Secondary
outcomes

Nominal data

Chi Square or
Fisher's Exact

Secondary
outcomes

Continuous
data

Student's t-test
or
Mann-Whitney
U test

Baseline Characteristics:
Chi Square test if nominal
Student's t-test if ordinal

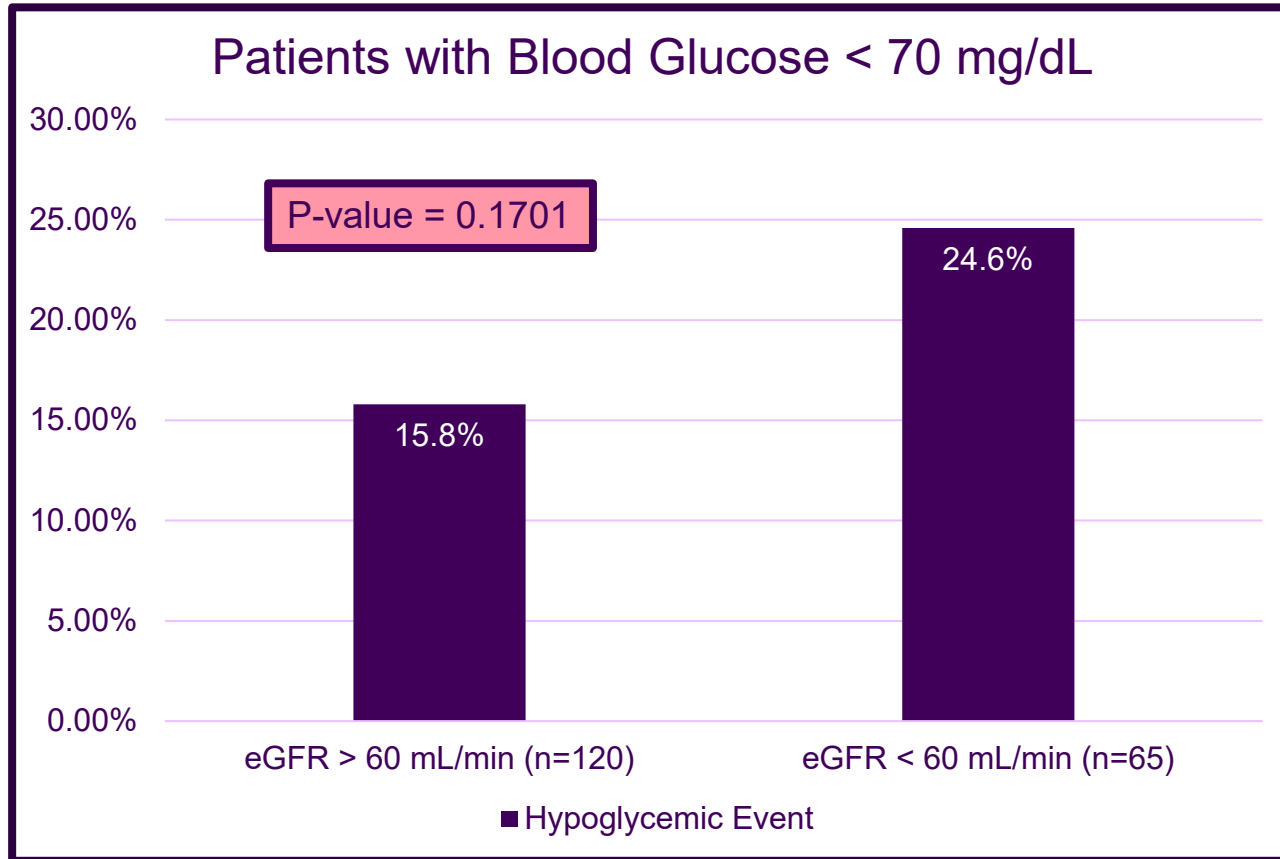
Results: Baseline Characteristics

Baseline Characteristics	eGFR \geq 60 mL/min (n=120)	eGFR < 60 mL/min (n=65)	P-Value
Age, years \pm SD	37.9 \pm 17.8	58.7 \pm 17.2	< 0.001
Female, no. (%)	72 (60)	29 (44.6)	0.063
Caucasian, no. (%)	75 (62.5)	44 (67.7)	0.523
T1DM, no. (%)	74 (61.7)	21 (32.3)	< 0.001
eGFR on Admission, mL/min \pm SD	-	33.6 \pm 15.4	-
Baseline Potassium, mg/dL \pm SD	4.4 \pm 0.7	4.8 \pm 1.0	0.002
BG on Admission, mg/dL \pm SD	454.3 \pm 147.6	596.9 \pm 335.2	< 0.001

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Results: Primary Outcome



Results: Subgroup Analyses of Primary Outcome

Age \geq 65 years	eGFR \geq 60 mL/min (n=13)	eGFR < 60 mL/min (n=21)	P-Value
BG < 70 mg/dL, no. (%)	1 (7.7)	6 (28.6)	0.21
T1DM	eGFR \geq 60 mL/min (n=74)	eGFR < 60 mL/min (n=21)	P-Value
BG < 70 mg/dL, no. (%)	11 (14.9)	5 (23.8)	0.34
T2DM	eGFR \geq 60 mL/min (n=46)	eGFR < 60 mL/min (n=45)	P-Value
BG < 70 mg/dL, no. (%)	8 (17.4)	11 (24.4)	0.45
Nephrology/Endocrine Consult	eGFR \geq 60 mL/min (n=59)	eGFR < 60 mL/min (n=34)	P-Value
BG < 70 mg/dL, no. (%)	8 (13.6)	8 (23.5)	0.26

Results: Secondary Outcomes

Secondary Outcome	eGFR \geq 60 mL/min (n=120)	eGFR: 30-59 mL/min CKD Stage IIIa/IIIb (n=41)	P-Value
BG < 70 mg/dL, no. (%)	19 (15.8)	12 (29.3)	0.07
Secondary Outcome	eGFR \geq 60 mL/min (n=120)	eGFR: 15-29 mL/min CKD Stage IV (n=13)	P-Value
BG < 70 mg/dL, no. (%)	19 (15.8)	2 (15.4)	1.0
Secondary Outcome	eGFR \geq 60 mL/min (n=120)	eGFR: < 15 mL/min CKD Stage V (n=11)	P-Value
BG < 70 mg/dL, no. (%)	19 (15.8)	2 (18.2)	0.69

Results: Secondary Outcomes

Secondary Outcome Data	eGFR \geq 60 mL/min (n=120)	eGFR < 60 mL/min (n=65)	P-Value
BG drop > 200 mg/dL in 1 hour, no. (%)	2 (1.7)	4 (6.1)	0.186
Potassium > 5 mg/dL, no. (%)	15 (17.5)	21 (32.3)	0.002
Potassium < 3.5 mg/dL, no. (%)	75 (62.5)	38 (58.5)	0.637
Median length of stay, days (IQR)	3 (2-4)	5 (3-9)	< 0.001
Median length of ICU stay, days (IQR)	0 (0-1)	2 (0-3)	< 0.001
Mortality, no. (%)	0 (0)	5 (7.7)	0.005

Results: Secondary Outcomes

Secondary Outcome Data	eGFR \geq 60 mL/min (n=120)	eGFR < 60 mL/min (n=65)	P-Value
BG drop > 200 mg/dL in 1 hour, no. (%)	2 (1.7)	4 (6.1)	0.186
Potassium > 5 mg/dL, no. (%)	15 (17.5)	21 (32.3)	0.002
Potassium < 3.5 mg/dL, no. (%)	75 (62.5)	38 (58.5)	0.637
Median length of stay, days (IQR)	3 (2-4)	5 (3-9)	< 0.001
Median length of ICU stay, days (IQR)	0 (0-1)	2 (0-3)	< 0.001
Mortality, no. (%)	0 (0)	5 (7.7)	0.005

Discussion

Benefits

- Addition to current literature
- Protocol at Mercy Hospital St. Louis is effective

Limitations

- Retrospective design
- Multiple readmissions for DKA and HHS
- Relying on diagnosis codes for patient sample

Future Research for Study Groups

- Differentiate between DKA and HHS
- Transitioning from insulin drip to subcutaneous insulin

Conclusion

Previous study showed higher incidence of hypoglycemic events in patients with ESRD

This study showed no difference in incidence of hypoglycemia for patients with impaired renal function

More studies needed to evaluate if and when insulin IV continuous infusion should be adjusted for impaired renal function

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