Safe Implementation of a Hyperglycemic Crises Protocol by Utilizing a Conversion Table

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Disclosures

Authors have nothing to disclose

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Lenox Hill Hospital is a comprehensive acute care hospital facility located in New York City. It is recognized nationally for its outstanding patient care, as well as its innovative medical/surgical modalities.

Our Mission

To improve the health and quality of life for the people and communities we serve by providing world-class service and patient-centered care.

Our Vision

To be a national health care leader, committed to excellence, compassion and improving the health of the community.

Our Values

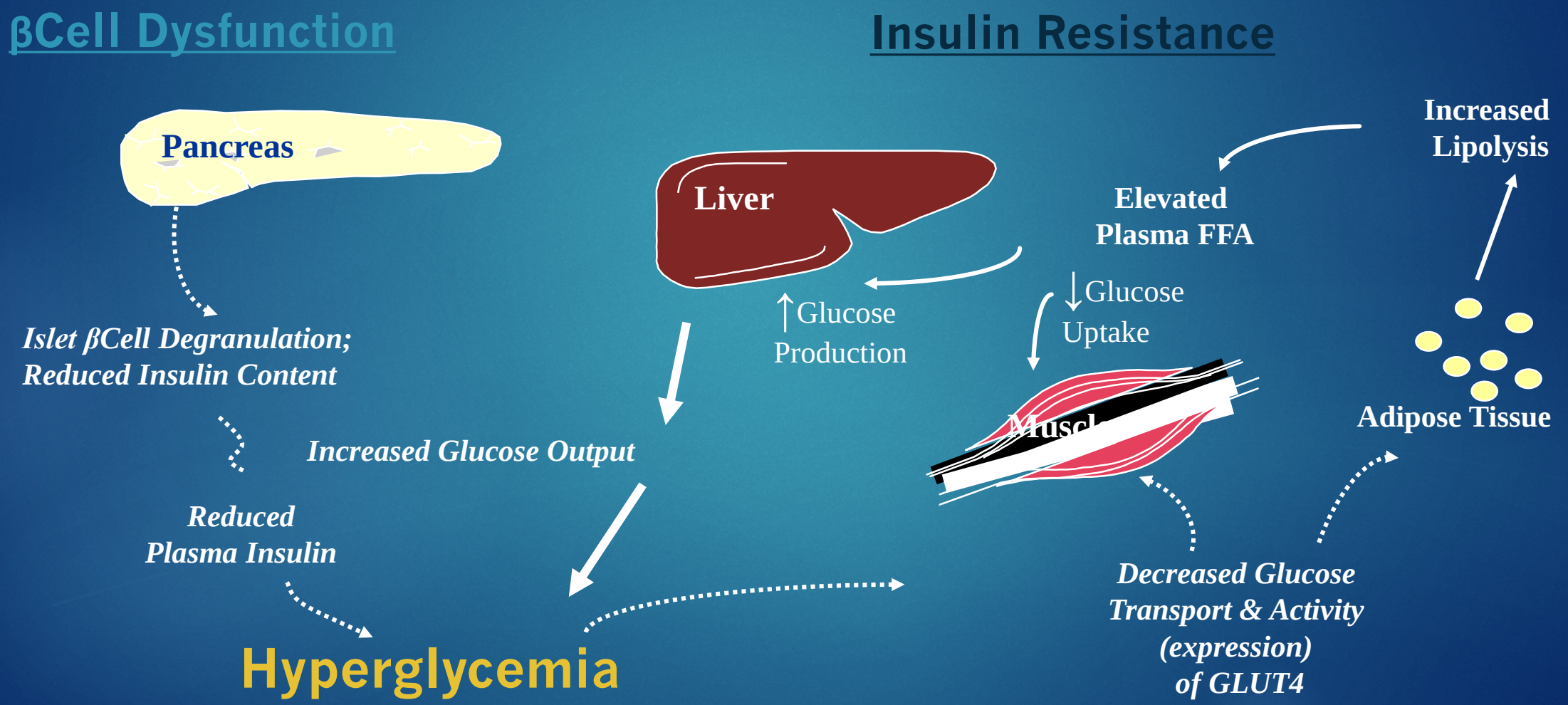
Excellence Innovation Caring Integrity

Diabetes Mellitus - Definition

- Diabetes mellitus is a group of metabolic diseases characterized by hyperglycemia resulting from defects in insulin secretion, insulin action, or both.[1]

- The name 'diabetes mellitus' is derived from:
  - Greek: ‘diabetes’ – “siphon” or “to pass through”
  - Latin: 'mellitus' – “honeyed” or “sweet”[2]

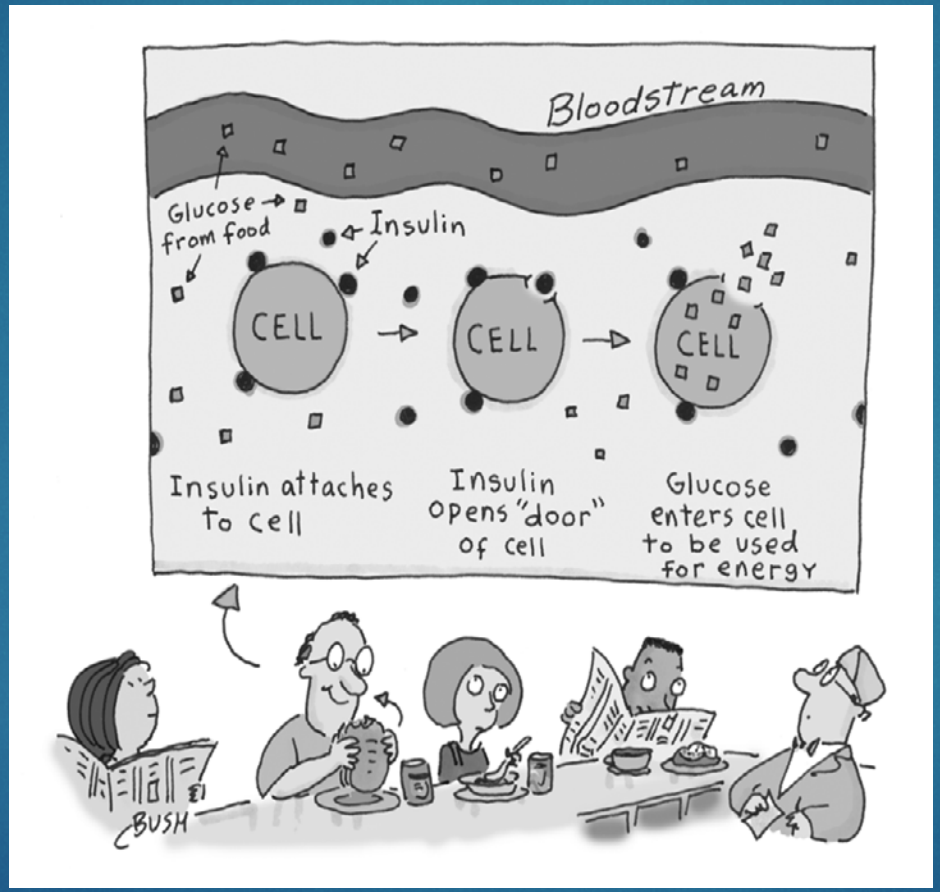
βcell dysfunction and insulin resistance produce hyperglycemia in type 2 diabetes



Diabetes Mellitus

- Type 1 Diabetes
- Type 2 Diabetes
- Gestational Diabetes Mellitus
- Maturity Onset Diabetes of Young (MODY)
- Latent Autoimmune Diabetes Adult
- Flatbush Diabetes-Type 1B Idiopathic
- Endocrinopathies
- Drug Induced

Insulin Mechanism



http://southsidediabetes.com/patients/controlling-your-diabetes/

Intravenous Insulin vs Subcutaneous

OF NOTE: **Only** Regular Insulin can be given intravenously (in the treatment of hyperglycemic crises).

Regular Insulin has an **IMMEDIATE** onset of action with a half life of 9 minutes.

Hyperglycemic Crises

- Diabetic ketoacidosis (DKA) and Hyperosmolar hyperglycemic state (HHS) are medical emergencies associated with increased morbidity, mortality and healthcare costs (Joslin, 2013).
- Prompt identification and proper management of these emergencies are imperative to improve patient outcomes and prevent death (Juneja, et al., 2009).
- Intravenous (IV) insulin is adopted for treatment of hyperglycemia in the critical care setting (DeSalvo, Greenberg, Henderson, & Cogen, 2012;ADA, 2017;Kreider & Lien, 2015).
- Insulin use is renowned for positive clinical outcomes however the risk of hypoglycemia and its accompanying negative sequelae are inherent.
- IV insulin drips necessitate enhanced critical thinking skills, vigilant monitoring of lab values, titration of fluid, electrolytes and insulin.

Diabetic Ketoacidosis (DKA)

- Occurs when the body does not get the glucose needed for energy because the there is no insulin to get the glucose in the cells
- Without glucose, the body starts to burn fat for energy, which produces ketones.
- When ketones build up in the blood, they make it more acidic
- Seen usually with Type 1 diabetics and in rare cases, Type 2
- Can be seen even when blood glucose is only > 250
- Usually precipitated by missing insulin doses or infection/illness

Diabetic Ketoacidosis (DKA)

- DKA is characterized by hyperglycemia, ketosis/ketonemia, acidosis and volume depletion. The diagnosis of DKA should be made based on the 3 of the 4 following criteria:
    a. hyperglycemia with blood glucose (BG) > 250 mg/dL
    b. arterial pH < 7.30 and/or serum bicarbonate < 18 mEq/L
    c. anion Gap > 12
    d. presence of ketonemia and/or moderate ketonuria
- Treatment is electrolyte management & insulin drip infusion with some dextrose containing hydration to prevent a rapid decrease in blood glucose

Hyperosmolar Hyperglycemic State (HHS)

- In HHS, blood sugar levels rise, **and the body tries compensate by getting rid of the excess sugar by passing it** into the urine.
- Eventually the longer the blood sugar goes uncontrolled, the less one urinates because they are becoming dehydrated after putting out so much urine initially.
- HHS can lead to severe dehydration if not caught and treated manifesting as seizures, coma and eventually death.
- HHS can take days or weeks to develop.
- Often BG is > 600, have altered mental status, but no ketones are present because of some insulin being secreted from the pancreas
- **Treatment is more fluids than insulin.**
- Some pts may be glucose toxic and require high doses of insulin before hyperglycemia resolves.

Hyperosmolar Hyperglycemic State (HHS)

- HHS is characterized by:
- a .hyperglycemia (usually BG > 600 mg/dL)
- b. **volume depletion (usually 8-10 liters)**
- c. hyperosmolality* (serum Osm > 320 mOsm/kg)
- d. altered mental status
- e. normal pH and serum bicarbonate > 15 mEq/L
- f. small to absent ketonemia/ketonuria.
- g. normal anion gap

Methods

- An inter-professional collaborative effort, based on evidenced based studies (DeSalvo, Greenberg, Henderson, & Cogen, 2012;Myers, Zilch & Rodriquez,2013) developed and sought to pilot a hyperglycemic crises protocol (on the critical care units) that facilitated an appropriate and timely management of patients presenting with DKA or HHS.
- Such interventions contribute to length of stay reductions and associated complications of an ICU admission.
- Every effort to restore patients to diabetic control must be advocated for.
- Preliminary hyperglycemic crises protocol drafts, piloted on critical care units, required nursing estimation for insulin titration thus impacting accuracy and patient safety.
- Estimation of insulin could have had the potential to cause nurses to erroneously administer IV insulin drips. Immediate efforts to address this injurious practice were necessitated prior to patient harm occurrence.

Methods

- This hyperglycemic crises protocol was presented to the nursing critical care collaborative council, an interdisciplinary team, for consideration, input, approval and stakeholder buy-in.
- The Chief Nursing Officer strongly advocated for clarification regarding scope of practice regarding IV insulin titration, by registered nurses, in the ICU setting.
- As a response, the New York State Office of Professional Licensure indicated that these tasks are definitely within critical care nurses scope of practice when accompanied by the facility to decrease medication errors.
- A conversion table was developed (by S. Patterson) in order to assure accuracy of insulin drip calculation while fostering an environment of safety for both staff and patients alike.
- Buy- in from staff was essential in the successful implementation of the pilot program which lead to the establishment of the protocol as an adjunct in the clinical management of patients presenting with DKA and HHS.

Original Conversion Table

Blood Glucose	Insulin Infusion
0-150 mg/dL	1. Hold insulin infusion. 2. If BG < 60 mg/dL, give 25g D50W IV push and recheck BG in 15 minutes. Repeat until BG > 60 mg/dL. 3. If BG between 60-99 mg/dL, give 12.5g D50W IV push and recheck BG in 15 minutes. Repeat until BG > 99 mg/dL. 4. Once BG > 100 mg/dL, check BG q1hour. 5. When BG > 200 mg/dL, resume insulin infusion at 50% of the previous infusion rate (i.e. prior to holding the infusion).
151-250 mg/dL	- Start Dextrose-containing infusion and titrate dextrose to maintain BG 150-250 mg/dL - Continue insulin drip per titration below* *Do not use less than 0.05 units/kg/hr until DKA/HHS completely resolve
Change in Blood Glucose UP	INSULIN INFUSION TITRATION
0 - 24 mg/dL	Increase drip by 1 unit/hr (15% increase?)
25 - 49 mg/dL	Increase drip by 2 units/hr (30% increase?)
50 -74 mg/dL	Increase drip by 3 units/hr (40% increase?)
75 - 100 mg/dL	Increase drip by 4 units/hr (50% increase?)
> 100 mg/dL	Bolus current rate then INCREASE drip by 2 units/hr (30%)
Change in Blood Glucose DOWN	INSULIN INFUSION TITRATION
0 - 49 mg/dL	LEAVE drip at current rate
50 - 74 mg/dL	Decrease drip by 2 units/hr (15% decrease?)
75 - 100 mg/dL	Decrease drip by 4 units/hr (30% decrease?)
> 100 mg/dL	CUT DRIP RATE IN HALF*

DKA/HHS TREATMENT: INSULIN INFUSION ALGORITHM
*** DO NOT ABRUPTLY STOP INSULIN DRIP AS THIS WILL RESULT IN PERSISTENT DKA.**

Conversion Table

DKA/HHS TREATMENT: INSULIN INFUSION ALGORITHM (PAGE 1 OF 2)

INSULIN INFUSION TITRATION FOR BLOOD GLUCOSE Greater than 250 mg/dL			
CHANGE IN BLOOD GLUCOSE UP		CHANGE IN BLOOD GLUCOSE DOWN	
0 - 24 mg/dL	Increase drip by 15%	0 - 49 mg/dL	LEAVE drip at current rate
25 - 49 mg/dL	Increase drip by 30%		
50 -74 mg/dL	Increase drip by 40%	50 - 74 mg/dL	Decrease drip by 15%
75 - 100 mg/dL	Increase drip by 50%	75 - 100 mg/dL	Decrease drip by 30%
> 100 mg/dL	Bolus current rate then INCREASE drip by 30%	> 100 mg/dL	Decrease drip by 50% **

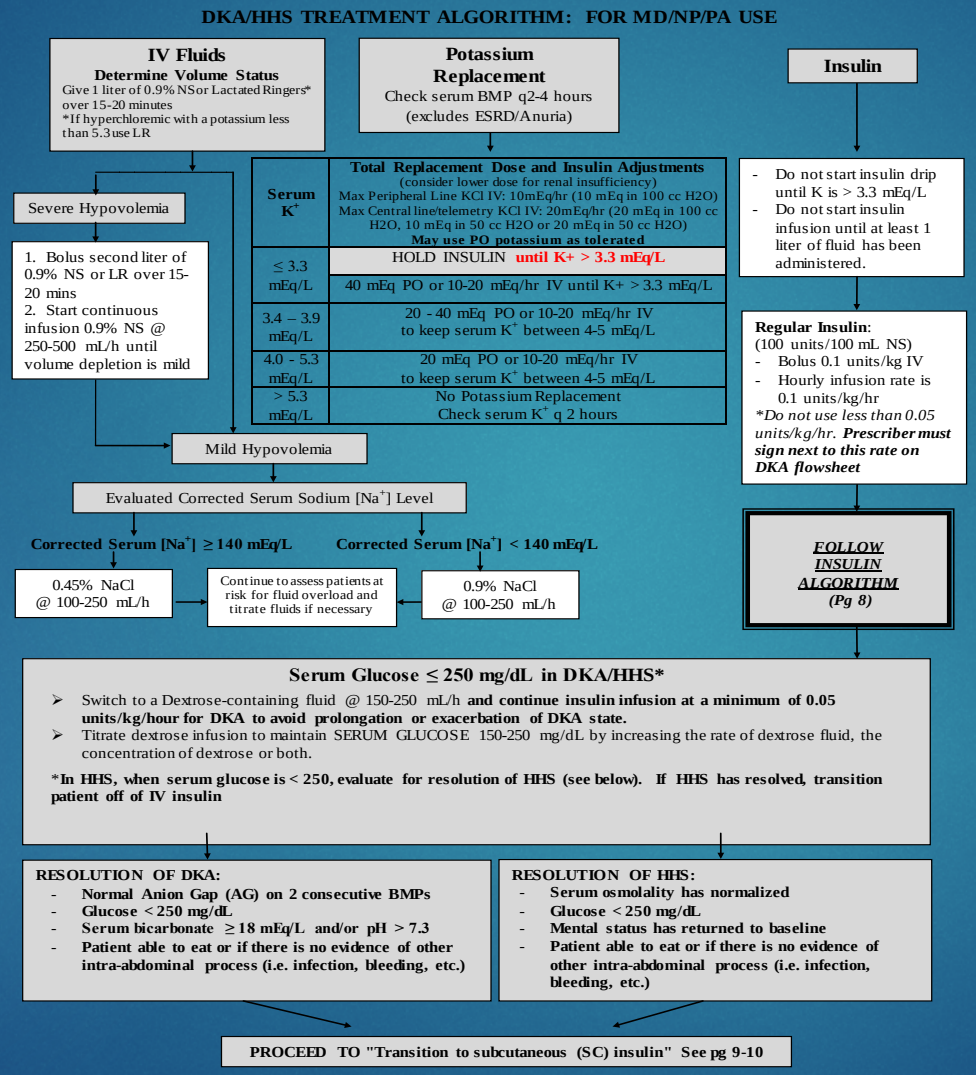
INSULIN INFUSION TITRATION (% to UNITS/HOUR CONVERSION CHART)

CHANGE IN BLOOD GLUCOSE UP Increase by this amounts in units/hour				CURRENT RATE (units/hour)	CHANGE IN BLOOD GLUCOSE DOWN Decrease by this amounts in units/hour		
+15%	+30%	+40%	+50%		-15%	-30%	-50%
+0.3	+0.6	+0.8	+1	2-2.9	-0.3	-0.6	-1
+0.5	+0.9	+1.2	+1.5	3-3.9	-0.5	-0.9	-1.5
+0.6	+1.2	+1.6	+2	4-4.9	-0.6	-1.2	-2
+0.8	+1.5	+2	+2.5	5-5.9	-0.8	-1.5	-2.5
+0.9	+1.8	+2.4	+3	6-6.9	-0.9	-1.8	-3
+1.1	+2.1	+2.8	+3.5	7-7.9	-1.1	-2.1	-3.5
+1.2	+2.4	+3.2	+4	8-8.9	-1.2	-2.4	-4
+1.4	+2.7	+3.6	+4.5	9-9.9	-1.4	-2.7	-4.5
+1.5	+3	+4	+5	≥10	-1.5	-3	-5

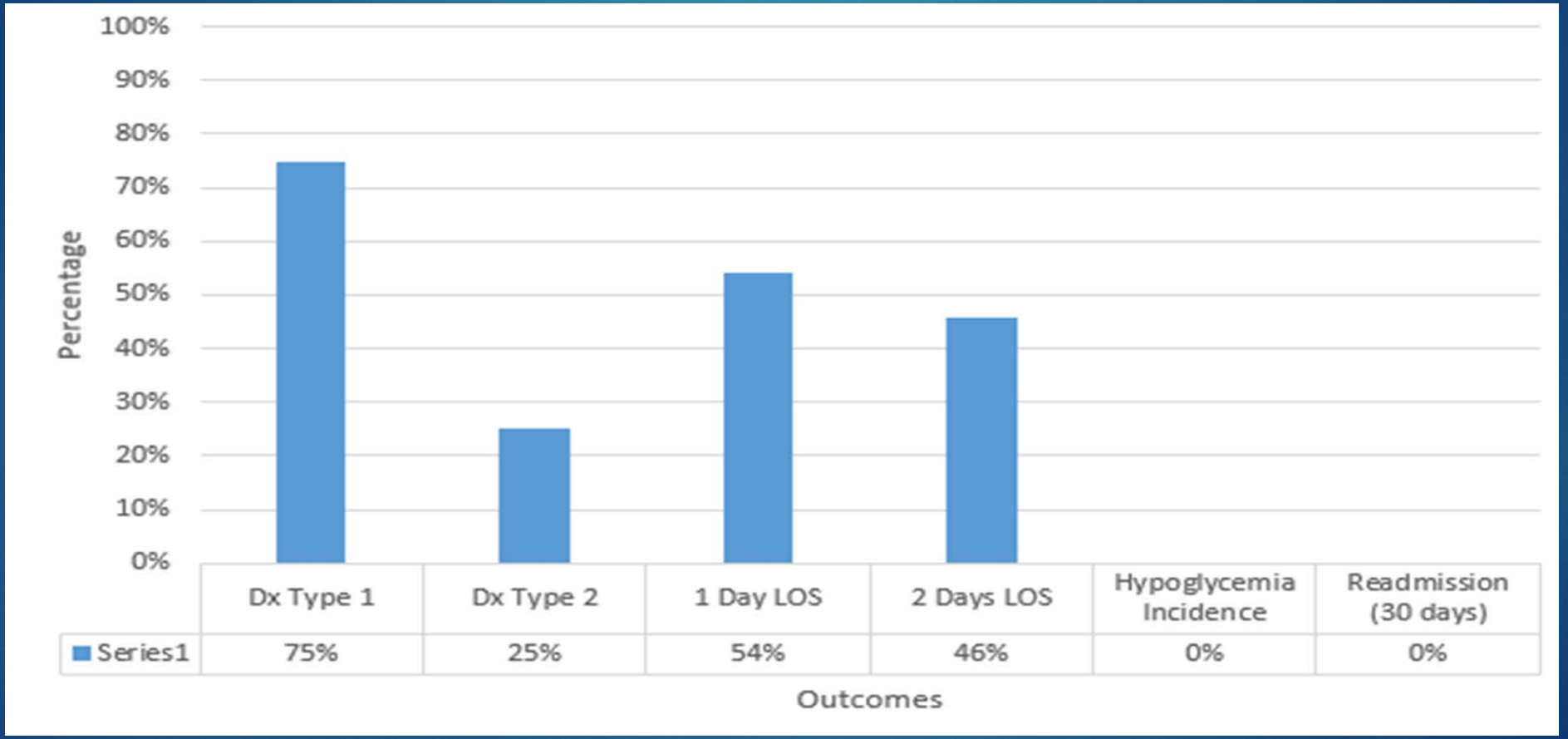
NOTIFY PROVIDER WHEN HOURLY INSULIN RATE EXCEEDS 12 UNITS / HOUR

SEE TABLE ON NEXT PAGE FOR INSTRUCTIONS RE: BG < 250 mg/dL

Lenox Hill DKA/HHS Protocol



Results


100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Percentage
Dx Type 1
Dx Type 2
1 Day LOS
2 Days LOS
Hypoglycemia Incidence
Readmission (30 days)
Series1
75%
25%
54%
46%
0%
0%
Outcomes

Conclusion

- Resulting evidence, from internal diabetes dashboard, included:
  - decreased length of stay – which facilitated availability of precious ICU beds for other patients that warranted a higher level of care
  - decreased incidence of hypoglycemia in DKA or HHS patients admitted to the ICU.
  - ongoing education and competency evaluation is maintained annually via skills fairs, briefs, and huddles.

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Thank You So Very Much