

Background

- ICU patients have a higher risk of developing hyperglycemia or hypoglycemia due to inadequate medication regimens, stress, and comorbid conditions. Prolonged uncontrolled hyperglycemia or hypoglycemia, in these patients can lead to further complications such as increased organ dysfunction, longer hospital stays, and long-term neurological damage.
- In the NICE-SUGAR study, researchers found that patients managed with intensive glucose control (target blood glucose range of 81-108 mg/dL) had higher rates of mortality compared to patients managed with conventional glucose control (target of ≤ 180 mg/dL).
- The Insulin: IV Infusion Critically Ill Patients order set at MemorialCare Long Beach Medical Center targets optimal blood glucose levels between 140-180 mg/dL and clinically acceptable levels between 100-180 mg/dL.

Objectives

- Primary objectives** – retrospectively evaluate the current insulin dosing protocol in the adult ICU, specifically:
- Percentage of patients who achieved the first target blood glucose goal of 140-180 mg/dL or the clinically acceptable goal of 100-180 mg/dL within the first 12 and 24 hours of starting insulin therapy
 - Percentage of patients who achieved 4 consecutive blood glucose levels within the goal range within 12 and 24 hours of starting insulin therapy

Secondary objectives

- Incidence of hypoglycemic events for duration of insulin therapy
- Effect of other factors, including steroids, vasopressors, parenteral nutrition, and BMI on reaching target blood glucose levels
- Nursing adherence to insulin protocol

Methods

Study Design

This was a single-center, retrospective analysis of electronic medical records at MemorialCare Long Beach Medical Center. The study spanned from January 2023 through September 2023.

Inclusion Criteria

- Age ≥ 18 years old
- Patients admitted to the ICU for > 2 days
- Patients receiving insulin infusion for hyperglycemia using the Insulin: IV Infusion Critically Ill Patients order set

Exclusion Criteria

- Pregnant patients
- Patients receiving insulin therapy for organ donation
- Patients on insulin therapy for diabetic ketoacidosis, hyperosmolar state, or indication other than hyperglycemia
- Post-cardiac surgery patients

Limitations

- Retrospective chart review
- Small sample size
- Insulin protocol was not adhered to strictly by nursing staff with regards to timing of hourly POC blood glucose testing and corresponding rate changes
- No consideration for previous or concurrent diabetes medication usage

Results

Figure 1: Baseline Characteristics

Baseline Characteristics (n=41)	
Age	
Age; mean (years)	60.4
Gender; n (%)	
Male	23 (56.1)
Weight	
Weight; mean (kg)	89.1
BMI >30 ; n (%)	16 (39)
Hgb A1c	
Hgb A1c; mean	8
Comorbidities; n (%)	
Diabetes	27 (65.9)
Concurrent Medications/Feedings; n (%)	
Corticosteroids	14 (34.1)
Enteral Feeds	16 (39.0)
Parenteral Nutrition	3 (7.3)
Vasoactive Medication(s)	28 (68.3)

Figure 2: Data Collection

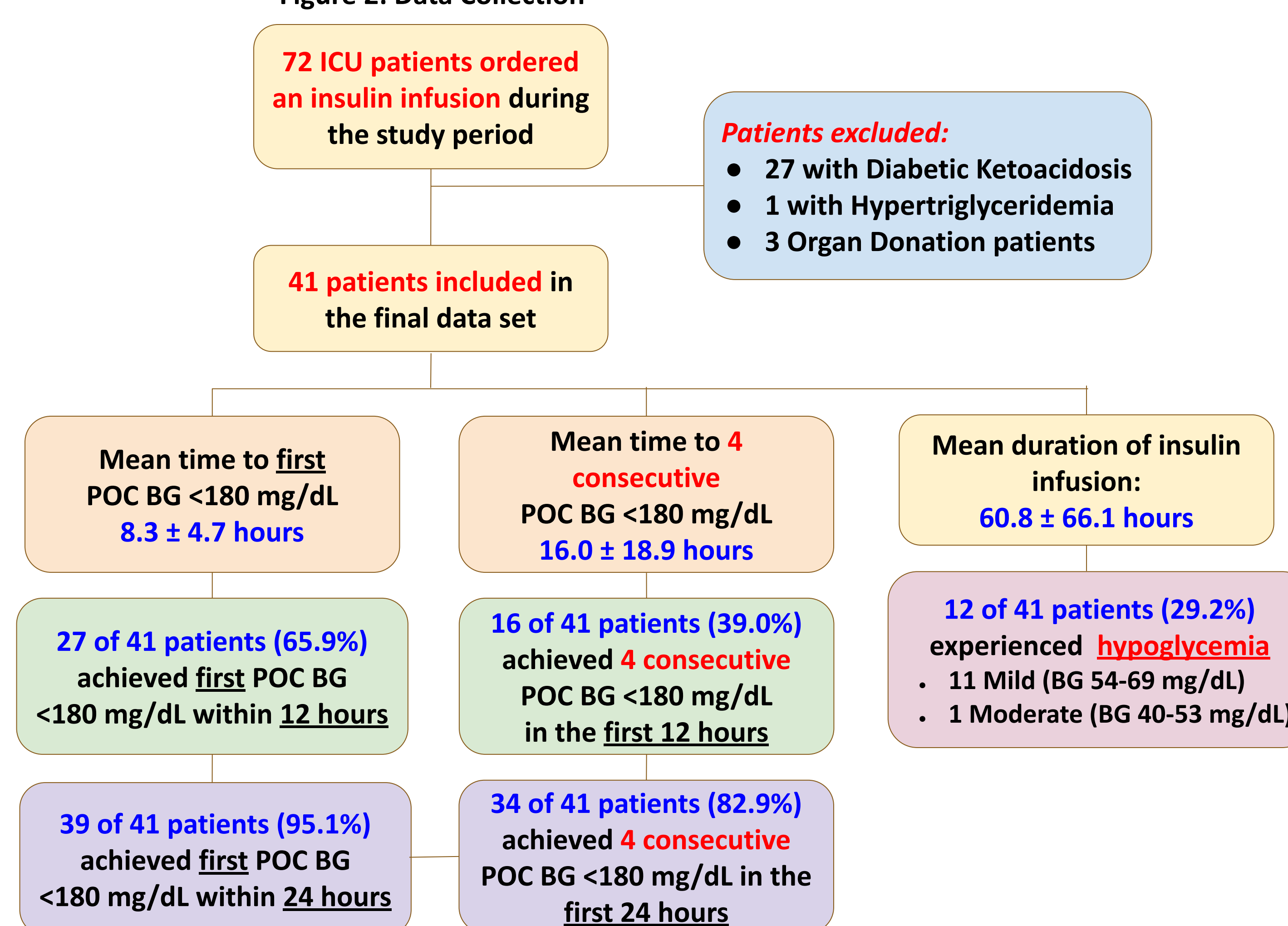


Figure 3: Mean Goal Times vs Comorbidities/Body Mass Index (BMI)

* n=39 for all patients since 2 patients did not reach the blood glucose goals for the duration of insulin infusion

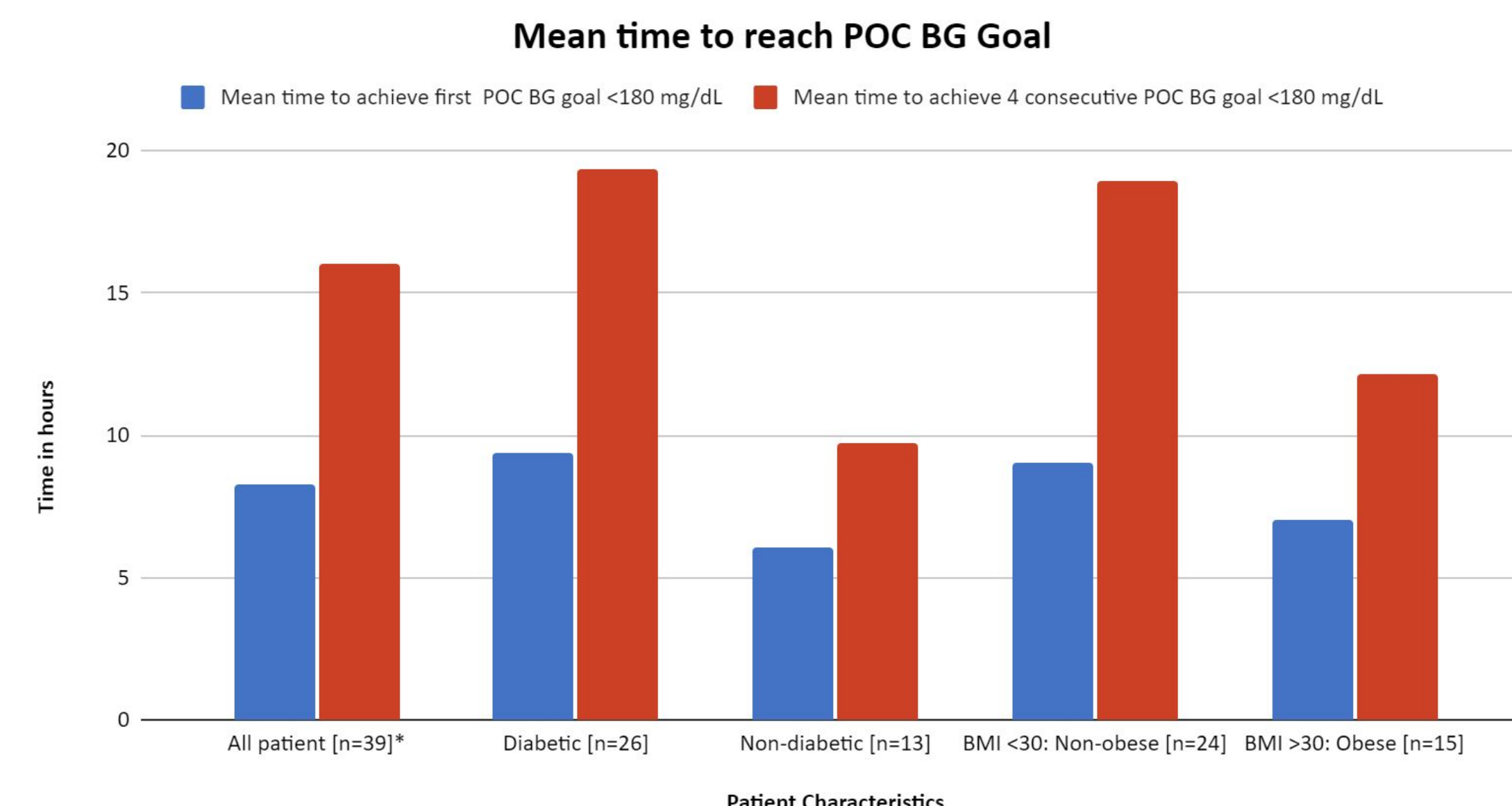


Figure 4: Mean Goal Times vs Concurrent Medication/Feedings

	Mean time to first POC BG < 180 mg/dL (hours)	
	Yes	No
Corticosteroids	8.2 ± 4.6	8.3 ± 4.6
Enteral Feeding	8.7 ± 5.1	8.0 ± 4.6
Parenteral Nutrition	5.5 ± 1.1	8.5 ± 4.8
Vasoactive Medication(s)	9.0 ± 5.1	6.8 ± 3.7
	Mean time to achieve 4 consecutive POC BG < 180 mg/dL (hours)	
	Yes	No
Corticosteroids	12.4 ± 23.9	18.2 ± 23.5
Enteral Feeding	12.6 ± 4.7	18.0 ± 23.6
Parenteral Nutrition	8.6 ± 1.1	16.7 ± 19.7
Vasoactive Medication(s)	13.4 ± 5.1	21.9 ± 33.2

Discussion

To assess the effectiveness of the current insulin protocol, time to reach the first POC BG <180 mg/dL, time to achieve 4 consecutive POC BG <180 mg/dL, and the percentage of patients able to achieve the goals within 12- and 24-hours of the initiation of the insulin infusion were determined. The mean time for all patients to achieve the first POC BG <180 mg/dL was 8.3 ± 4.7 hours. Within the first 12 and 24 hours of insulin infusion, 27 patients (65.9%) and 39 patients (95.1%) achieved the first POC BG <180 mg/dL, respectively. The mean time for patients to achieve 4 consecutive POC BG <180 mg/dL was 16.0 ± 18.9 hours. In addition, 12 patients (29.2%) and 34 patients (82.9%) achieved 4 consecutive POC BG <180 mg/dL within the first 12 and 24 hours of the insulin infusion, respectively. Among all the patients, the mean time to reach target glucose levels was longer in diabetic patients (9.4 ± 4.9 hours) compared with non-diabetic patients (6.0 ± 3.6 hours). The mean time to achieve 4 consecutive POC BG within goal for diabetic patients was 19.3 ± 22.7 hours compared to 9.7 ± 3.6 hours for non-diabetic patients. This difference may be attributed to patients with diabetes experiencing greater insulin resistance than those without, resulting in longer times to reach target glucose goals. Obesity or concurrent therapy with agents that may cause hyperglycemia (e.g., steroids, enteral feeding, parenteral nutrition and vasoactive agents) did not significantly impact the time to reach target glucose goals. Hypoglycemic events were observed in 12 patients (29.2%), with 11 patients classified as having mild hypoglycemia (54 to 69 mg/dL) and 1 patient classified as having moderate hypoglycemia (40 to 53 mg/dL). No patients experienced severe hypoglycemia. The incidence of POC BG values <70 was 1% of all POC BG values (1112 total POC BG values) For a subset of 31 patients, nursing adherence with the insulin protocol was assessed regarding timing of POC BG testing and appropriateness of insulin dosing from the start of the insulin infusion until patients achieved 4 consecutive POC BG values in the target range. Of the 571 POC BG tests for these patients assessed, 79% (449 of 571) were at the designated frequency of every 1 or 2 hours and the specified time (± 15 minutes). An appropriate response to BG POC values (hold, increase, decrease, or continue the rate) was observed for 83% of the values. With regards to protocol adherence for individual patients, 48% of patients had the appropriate dose responses for at least 90% of the values. With regards to appropriate timing and frequency of POC BG testing, nurses performed them correctly for at least 90% of the time for 23% of patients.

Results (Continued)

Figure 5: Protocol Adherence

Adherence to Protocol by Patient*	
Percent Appropriate Frequency/Time of POC BG	No. Patients (%)
90-100%	7 (23)
75-89%	14 (45)
$<75\%$	10 (32)
Percent Appropriate Response to POC BG Value	No. Patients (%)
90-100%	14 (48)
75-89%	8 (26)
$<75\%$	9 (29)

* POC BG values and corresponding dose changes were evaluated from treatment initiation until 4 consecutive POC BG values were at goal

Conclusion

The mean time for patients to achieve the first POC blood glucose value within the goal range was 8.3 ± 4.7 hours, with 65.9% and 95.1% of patients achieving this goal within the first 12 and 24 hours of the start of the insulin infusion, respectively. The mean time for patients to achieve 4 consecutive POC blood glucose values within goal was 16.0 ± 18.9 hours, with 39.0% and 82.9% of patients achieving this goal within the first 12 and 24 hours of the insulin infusion, respectively. There were differences in the time to reach target glucose levels between patients with and without diabetes, with diabetic patients taking longer to reach the goal range. Future consideration should be given to developing a more aggressive insulin dosing protocol for patients with diabetes. With regards to safety, although there were 12 patients who experienced hypoglycemia, 11 of the patients had mild hyperglycemia and 1 had moderate hyperglycemia. No patients experienced severe hyperglycemia. Approximately 80% nursing adherence to the insulin protocol was observed regarding POC BG testing frequency and insulin dosing adjustments based on measured values. However, delays, infrequent testing, and inappropriate responses may have affected the protocol's effectiveness in managing hyperglycemia in ICU patients. Re-educating nurses and providing tools for proper timing, frequency of testing, and insulin dosing adjustments could improve adherence and provide more data to assess safety and efficacy.

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