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ORIGINAL ARTICLE

ASSESSING THE EFFECTIVENESS OF CONTINUOUS GLUCOSE MONITORING (CGM) IN ICU SETTINGS

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ABSTRACT

Background: Effective glycemic rheostat in censoriously ill affected people is associated with improved clinical outcomes. Traditional point-of-care (POC) glucose monitoring has limitations in detecting rapid glucose fluctuations. This study evaluated the effectiveness and medical utility of Continuous Glucose Monitoring (CGM) in ICU settings compared to standard POC testing.

Materials & Methods: A prospective observational study was conducted involving 100 ICU patients randomized into two clusters: CGM (n=50) and POC (n=50). Key outcomes included accuracy metrics (MARD, Clarke Error Grid), period in glucose series (70–180 mg/dL), incidence of hypo/hyperglycemic events, insulin adjustment frequency, and ICU outcomes (length of stay, mortality).

Results: CGM demonstrated high accuracy (MARD 10.2%) with 96.5% of readings in clinically acceptable zones. Time in range was pointedly higher in the CGM group (78.6% vs. 65.2%, $p < 0.001$), with fewer hypoglycemic events (0.4 vs. 1.1 per patient-day, $p = 0.002$) and hyperglycemic episodes (1.2 vs. 2.8 per patient, $p = 0.01$). CGM enabled more frequent insulin titration (4.5 vs. 2.7 adjustments/day, $p < 0.001$). No noteworthy differences were experiential in ICU length of stay or mortality.

Conclusion: CGM is a safe and accurate tool for glycemic management in ICU patients.

KEYWORDS: Continuous Glucose Monitoring; ICU, Glycemic Control; Traditional point-of-care (POC); CGM group; CGM demonstrated high accuracy.

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INTRODUCTION

For nearly two decades, there has been ongoing discussion about optimal glucose management in intensive care unit (ICU) affected people. Continuous glucose monitoring (CGM), as opposed to intermittent monitoring systems, can help avert unadorned hyperglycemia and hypoglycemia by permitting quicker and more precise regulations to insulin infusions through easier identification of glucose concentration trends.[1] Improved glycemic management is critical in the ICU to avoid complications. Continuous intravenous insulin (CII) therapy is typically recommended in the ICU to meet glycemic targets, as it allows rapid insulin dosage modifications to maintain glucose levels within a specific range.[2] However, this approach places a significant burden on staff, often requiring hourly testing via point-of-care (POC) glucose measurements for treatment adjustments. The first commercially available CGM devices were introduced in the 1990s.[3] In a hospital setting, a CGM sensor with factory calibration and accuracy comparable to most blood glucose monitors defined by many experts as a mean total relation variance (MARD) of less than 10% from reference would be highly valued, provided no special accuracy concerns arise from physiological changes

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in interstitial fluid (ISF) composition in critically ill patients.[4,5] Currently, POC glucose monitoring using portable meters for intermittent readings is the primary method for glucose control in the ICU. These readings guide injectable insulin administration via local algorithms. However, hand-held glucose meters are not calculated for ICU usage, and their accurateness is uncertain often worse than essential laboratory or analysis exclusively in patients who are hypoxic, anemic, or exposed to certain medications.[6] Hyperglycemia is common in patients admitted to medical ICUs. It remains unclear whether real-time (RT) CGM reduces hypoglycemia and expands glycemic regulator and erraticism in critically ill MICU affected patients with an Acute Physiology and Chronic Health Evaluation II (APACHE-II) score of ≥20.[7] Hospitals can use CGMs to reduce limb-stick POC capillary blood glucose tests, as well as the incidence of hypo- and hyperglycemic episodes. Hospital research has primarily focused on CGM accuracy, with outcomes data emerging more recently. Implementing a hospice CGM program necessitates collaboration among medical doctors, bedside nurtures, diabetes educationalists, and superintendents. Success depends on protocols for amassing, analyzing, stowing, and retorting to CGM data.[8] This study aims to assess CGM's effectiveness in ICU settings by evaluating its accuracy, reliability, and impact on clinical outcomes such as glycemic control, hypo/hyperglycemia frequency, and nursing workload. The findings may support evidence-based recommendations for broader CGM adoption in critical care, ultimately enhancing patient safety and care efficiency.

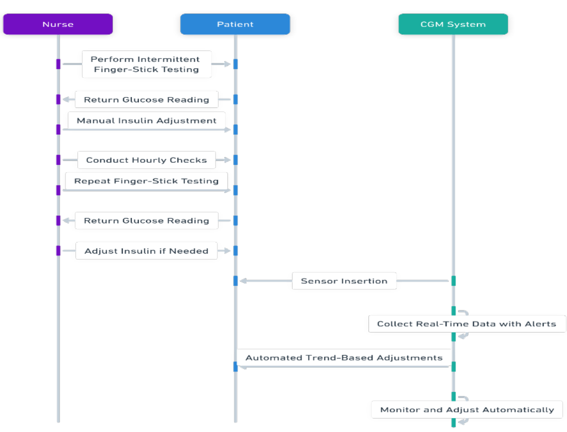

Figure 1: Glucose Monitoring Workflow

MATERIALS AND METHODOLOGY

Study Design: This forthcoming data-based multitude learning was directed over six months in Hospital ICU. The primary aim was to compare CGM accuracy, clinical utility, and patient outcomes against conventional POC glucose testing.

Participants: One hundred critically ill adults (≥18 years old) requiring glucose monitoring were included. Inclusion criteria: expected ICU stay >48 hours and need for insulin therapy. Exclusion criteria: severe edema, unresponsive hemodynamic instability, or skin conditions preventing sensor insertion.

Intervention: In this study, participants were randomized into two groups of 50 each to compare glucose monitoring methods in an ICU setting. The CGM Group underwent continuous glucose monitoring (CGM) using sensors applied according to manufacturer guidelines, while the POC Group followed standard ICU protocol with capillary point-of-care (POC) testing conducted every 1–4 hours. Data collection encompassed patient demographics and clinical characteristics, including age, sex, primary diagnosis, and comorbidities. Glucose measurements were recorded for both groups, alongside the incidence of hypoglycemia (<70 mg/dL) and hyperglycemia (>180 mg/dL), and the period consumed in the marked glucose range (TIR, 70–180 mg/dL). Additional metrics included the frequency of insulin adjustments, ICU length of stay, mortality, and sepsis incidence. CGM accurateness was gauged using Mean Absolute Relative Difference (MARD) and Clarke Error Grid scrutiny to assess its reliability compared to POC testing.

Statistical Analysis: Data analyzed using SPSS. Continuous variable quantity: mean ± SD or median (IQR), associated via t-tests or Mann-Whitney U tests. Categorical variable quantity: percentages, compared via chi-square or Fisher's exact test. Significance: $p < 0.05$.

RESULTS

Out of 100 ICU affected role, 50 were assigned to each group. Baseline characteristics were comparable ($p > 0.05$). CGM showed MARD 10.2% and 96.5% in Clarke Error Grid Zones A+B.

Table 2: Demographic and Clinical Characteristics

Variable	CGM Group (n=50)	POC Group (n=50)	p-value
Age (years)	63.5 ± 12.3	64.2 ± 11.7	0.72
Male (%)	58%	54%	0.68
Diabetes Mellitus (%)	70%	68%	0.81
APACHE II Score	21.1 ± 5.2	20.7 ± 5.5	0.63
ICU Stay (days)	7.5 ± 3.2	8.1 ± 3.7	0.31

Table 3: Glycemic Control Metrics

Metric	CGM Group	POC Group	p-value
Time in Range (70–180 mg/dL, %)	78.6 ± 8.4	65.2 ±10.7	<0.001
Hypoglycemic Events per Patient-Day	0.4 ± 0.2	1.1 ±0.5	0.002
Hyperglycemic Episodes/Patient	1.2 ± 0.6	2.8 ±1.1	0.01

Table 4: CGM Accuracy Metrics

Metric	Value
Mean Absolute Relative Difference (MARD)	10.2%
Clarke Error Grid Zone A + B (%)	96.5%
Sensor Calibration Errors	2

Table 5: Clinical Outcomes

Outcome	CGM Group	POC Group	p-value
Insulin Adjustments/Day	4.5 ±1.2	2.7 ±1.4	<0.001
ICU Length of Stay (days)	7.5 ±3.2	8.1 ±3.7	0.31
ICU Mortality (%)	12%	14%	0.72

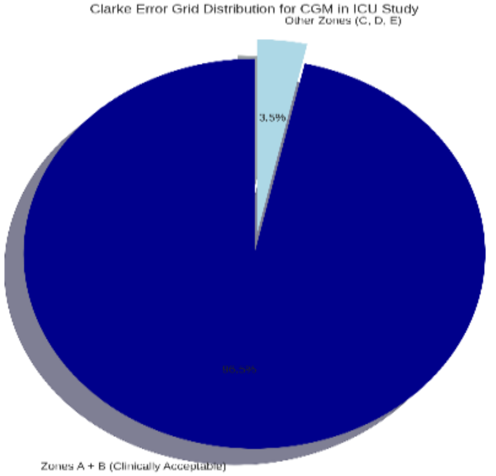

Figure 1: Pie Chart for Clarke Error Grid

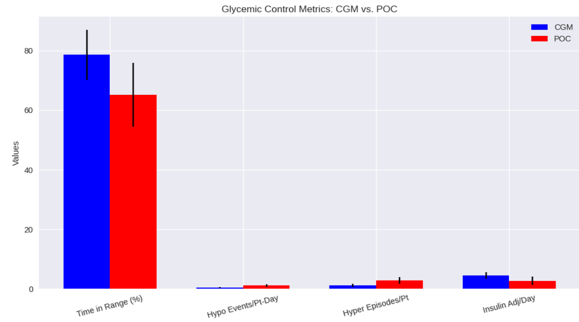

Figure 2: Bar Graph of Glycemic Control Metric.

DISCUSSION

The results highlight CGM's superior performance in ICU glycemic management compared to POC testing. Critically ill patients often experience glucose fluctuations due to stress, medications, and variable intake[15], making tight control challenging yet essential. CGM significantly increased time in target range, aligning with studies showing real-time data enables timely insulin titration.[9] The reduction in hypoglycemic events is notable, as hypoglycemia predicts ICU mortality.[10] CGM's alerts facilitate early intervention, potentially missed by intermittent POC. Frequent insulin adjustments in the CGM group reflect improved responsiveness, not increased workload prior research suggests CGM reduces nursing burden via fewer finger-sticks.[11] No differences in length of stay or mortality may stem from small sample size; larger trials could reveal long-term benefits .[12] Limitations include potential CGM inaccuracies during perfusion changes or rapid glucose shifts clinical validation with blood samples is advised despite acceptable MARD. Implementation barriers like cost and training persist.

CONCLUSION

Continuous Glucose Monitoring (CGM) was a safe, precise, and efficient way to manage blood sugar levels in critically ill intensive care unit patients, as this study shows. CGM considerably decreased the frequency of hypoglycemia and hyperglycemic episodes and increased time in the target glucose range compared to traditional Point-of-Care (POC) surveillance. CGM also made it easier to make prompt and accurate insulin adjustments, which improved the effectiveness of glucose management procedures.

Table 6: Breakdown of Hypo/Hyperglycemic Events by Severity

Event Type	Severity	CGM Group (Events/Patient)	POC Group (Events/Patient)	p-value
Hypoglycemia	Mild (<70 mg/dL)	0.3 ± 0.1	0.8 ± 0.4	0.003
	Severe (<54 mg/dL)	0.1 ± 0.1	0.3 ± 0.2	0.01
Hyperglycemia	Mild (>180 mg/dL)	0.9 ± 0.4	2.0 ± 0.8	0.005
	Severe (>250 mg/dL)	0.3 ± 0.2	0.8 ± 0.5	0.02

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CONFLICT OF INTEREST
Authors declare no conflict of interest.
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AUTHORS' CONTRIBUTION

The following authors have made substantial contributions to the manuscript as under:

Conception or Design:	SS, KM
Acquisition, Analysis or Interpretation of Data:	SS, KM, UA, SH, ASS, AR
Manuscript Writing & Approval:	SS, KM, UA, SH, ASS, ZZ

All the authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.