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Improving Glycemic Safety in Non-ICU Wards With Continuous Glucose Monitoring

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ABSTRACT

Continuous glucose monitoring (CGM) is increasingly being evaluated as an adjunct to point-of-care (POC) glucose testing in non-intensive care unit (non-ICU) hospital wards. Unlike intermittent POC measurements, CGM provides serial interstitial-glucose measurements and trend information that may reveal otherwise unrecognized glycaemic excursions. This narrative review critically synthesizes evidence from randomized controlled trials (RCTs), observational studies, systematic reviews and meta-analyses, clinical practice guidelines, and consensus statements, with emphasis on clinical effectiveness, analytical performance, safety, implementation, workflow, and economic considerations.

The literature search covered PubMed/MEDLINE, Embase, and the Cochrane Library for publications from January 2010 through 31 May 2025. The review was intentionally narrative because the evidence base is heterogeneous with respect to study design, patient populations, CGM devices, comparators, insulin protocols, and outcome definitions; quantitative pooling was therefore not undertaken in this review. A recent systematic review and meta-analysis identified six RCTs involving 979 non-critically ill hospitalized adults with diabetes. Compared with POC testing alone, adding CGM increased time in range by 7.24 percentage points (95% CI 5.06–9.42), reduced time below 70 mg/dL by 1.23 percentage points (95% CI −2.27 to −0.18), reduced time below 54 mg/dL by 0.95 percentage points (95% CI −1.19 to −0.70), and reduced time above 250 mg/dL by 3.70 percentage points (95% CI −6.10 to −1.29); no significant differences were observed in glycaemic variability or insulin dose. [13]

Across individual RCTs, CGM-assisted management generally improves glycaemic metrics and detection of hypo- and hyperglycaemia, whereas observational studies primarily support feasibility, workflow integration, and event detection. Current guidelines and consensus statements support inpatient CGM only within defined institutional protocols and with confirmatory POC testing when clinically indicated. Evidence for patient-centred outcomes such as length of stay, readmission, mortality, and cost-effectiveness remains limited. Analytical performance also varies by device and clinical context, and evidence does not justify a universal inpatient MARD threshold.

Overall, CGM should be regarded as an adjunct - not a replacement - for POC glucose monitoring in appropriately selected non-ICU adults. Its greatest current value is continuous

surveillance and trend information, while its routine use should remain contingent on patient selection, staff competency, institutional protocols, interoperability, and local regulatory and economic considerations. Larger pragmatic multicentre trials and standardized economic evaluations are needed before broader routine adoption can be recommended.

Keywords: Continuous glucose monitoring, diabetes, glycemic safety, hypoglycemia, hyperglycemia,

Abbreviations

CGM- continuous glucose monitoring, ICU- intensive care unit, POC- point of care

INTRODUCTION

Continuous glucose monitoring (CGM) enables near-real-time assessment of interstitial glucose, providing repeated measurements, directional trends, and, in some systems, alerts for impending glycaemic excursions. These features differ fundamentally from intermittent capillary point-of-care (POC) testing, which provides discrete measurements at scheduled times. [1]

The benefits of CGM are well established in ambulatory diabetes care. Randomized trials and meta-analyses in outpatient populations have demonstrated improvements in glycaemic control and selected patient-reported outcomes. [2-4] These findings provide biological and technological rationale for inpatient evaluation, but they should not be extrapolated directly to non-ICU hospitalized patients because acute illness, altered perfusion, medication exposure, nutrition, staffing, and treatment protocols may affect both sensor performance and clinical decision-making.

Hyperglycaemia and hypoglycaemia are common in hospitalized adults and are associated with adverse clinical outcomes. Hospital guidelines emphasize structured glycaemic management and recognize that inpatient glucose targets must be balanced against the risks of hypoglycaemia and treatment-related harm. [5-7]

Despite advances in diabetes technology, intermittent POC testing remains central to inpatient insulin management. Its limitation is temporal sampling: clinically relevant excursions may occur between scheduled measurements. CGM may address this surveillance gap, but its value depends on whether additional glucose information translates into safer or more effective treatment rather than simply generating more measurements. [1,6-8]

The clinical question is therefore not whether CGM can measure glucose continuously, but when and how CGM adds clinically useful information to established POC-based care. This review focuses on that question in non-ICU hospitalized adults and critically examines efficacy, accuracy, safety, implementation, cost, and the strength and limitations of the available evidence.

The objective was to synthesize evidence according to study design, distinguish established findings from areas of uncertainty, and identify practical conditions under which CGM may be used safely as an adjunct to POC monitoring.

METHODOLOGY

Search strategy and study selection

A narrative literature review was undertaken to evaluate the use of continuous glucose monitoring (CGM) in adults hospitalized in non-intensive care unit (non-ICU) settings. The narrative design was selected because the literature spans efficacy RCTs, diagnostic/accuracy studies, observational implementation studies, systematic reviews, guidelines, and consensus documents with substantial heterogeneity in patient populations, devices, comparators, insulin protocols, follow-up periods, and outcome definitions. The purpose was therefore to integrate complementary evidence types and critically interpret their clinical implications

rather than generate a pooled effect estimate from non-equivalent studies.

Database searches were conducted in PubMed/MEDLINE, Embase, and the Cochrane Library, covering publications from 1 January 2010 through 31 May 2025. The final search date was 31 May 2025. These keywords and Medical Subject Headings (MeSH) terms were used; "Continuous Glucose Monitoring", "flash glucose monitoring", "glucose sensor", "Hospitals", "Hospitalization", "Inpatients", “hospital”, “inpatient”, “hospital patient”, and "Diabetes Mellitus". Boolean operators ‘AND’ and ‘OR’ were used to combine these MeSH terms and keywords effectively.

Records were screened in two stages: title/abstract screening followed by full-text assessment against predefined eligibility criteria. Eligible evidence comprised RCTs, prospective or retrospective observational studies, systematic reviews/meta-analyses, clinical practice guidelines, and consensus statements addressing CGM in adult non-ICU inpatients. Reference lists of key eligible reviews, trials, guidelines, and consensus documents were hand-searched for additional relevant studies; however, citation chasing was restricted to records meeting the same eligibility criteria and publication cutoff.

Studies were included when they evaluated clinical effectiveness, detection of glycaemic events, analytical performance, safety, implementation/workflow, or health-economic aspects of CGM in adult non-critically ill hospitalized patients. Studies focused exclusively on children, ICU populations, perioperative monitoring, outpatient care, pregnancy/gestational diabetes, conference abstracts, editorials, letters, and non-English publications were excluded. When studies included mixed ICU and non-ICU populations without separately extractable non-ICU results, they were excluded.

A quantitative meta-analysis was not performed because the eligible evidence was clinically and methodologically heterogeneous. Differences included CGM platforms and sensor generations, real-time versus intermittently scanned systems, insulin regimens and titration protocols, POC comparators, glycaemic targets, definitions of hypoglycaemia/hyperglycaemia, monitoring duration, and outcome reporting. Rather than combining potentially non-comparable estimates, findings were synthesized by evidence type and thematic domain: clinical effectiveness, detection of dysglycaemia, analytical performance and safety, implementation and workflow, economics, and guideline/consensus recommendations. The recent meta-analysis by Chagas et al. was used as quantitative contextual evidence because it independently pooled six RCTs (979 participants), while the present review did not reproduce that meta-analysis. [13]

Evidence by study design and clinical effectiveness

RCTs provide the strongest direct evidence for causal effects of inpatient CGM-assisted management. Individual trials in non-ICU wards have reported improvements in time in range and reductions in glycaemic excursions when CGM is added to or used alongside conventional POC monitoring, although trial protocols, patient selection, and insulin algorithms differ. [10-12] The most recent systematic review and meta-analysis available within the May 2025 cutoff included six RCTs involving 979 adults and found that adding CGM to POC testing increased time in range by 7.24 percentage points and reduced time below 70 mg/dL, time below 54 mg/dL, and time above 250 mg/dL. It found no statistically significant difference in glycaemic variability or insulin dose. [13] These pooled findings support improvement in glycaemic metrics, but they do not establish reductions in mortality, length of stay, readmission, or other major clinical outcomes.

Observational studies and implementation reports complement RCT evidence by describing feasibility, nursing workflow,

remote monitoring, and detection of events that may occur between scheduled POC measurements. [9,14,15] However, these studies are vulnerable to selection bias, confounding, secular changes in inpatient practice, and differences in institutional protocols; therefore, they should not be interpreted as equivalent to randomized evidence for clinical effectiveness.

Systematic reviews and meta-analyses provide higher-level synthesis but remain dependent on the quality and comparability of their included studies. The Chagas meta-analysis is particularly relevant because it was restricted to randomized comparisons of CGM plus POC versus POC alone and reported statistically significant improvements in several time-in-range outcomes. [13] In contrast, scoping and narrative reviews are useful for identifying implementation issues and evidence gaps but cannot by themselves establish treatment efficacy. [9]

Guidelines and consensus statements are important for translating evidence into practice, but they represent recommendations rather than efficacy trials. The Endocrine Society guideline, ADA Standards of Care, and inpatient CGM consensus guidance support structured use of CGM in selected hospitalized adults, with continued reliance on POC testing when readings are discordant with the clinical picture or when clinically critical decisions are being made. [1,6-8] Thus, the evidence supports CGM primarily as an adjunctive surveillance and decision-support tool rather than as a stand-alone replacement for bedside glucose testing.

The COVID-19 pandemic accelerated interest in remote inpatient glucose monitoring and generated important implementation experience, including potential reductions in staff-patient contact. [14] These reports demonstrate feasibility under specific circumstances but should not be interpreted as proof of improved long-term clinical outcomes.

Evidence for patient-centred outcomes remains less mature than evidence for glycaemic metrics. Available studies do not yet provide consistent evidence that inpatient CGM reduces mortality, hospital length of stay, readmissions, or overall healthcare expenditure. Consequently, claims of broad clinical benefit should be moderated until larger multicentre pragmatic RCTs with patient-centred endpoints are available.

Taken together, the strongest evidence supports improved glycaemic surveillance and selected glycaemic outcomes when CGM is added to POC monitoring in appropriately selected non-ICU adults. The evidence is less definitive for hard clinical outcomes, universal applicability, and cost-effectiveness. This distinction is central to interpreting the current role of inpatient CGM.

Accuracy and Safety

Accurate glucose assessment is essential for safe insulin therapy. CGM measures interstitial rather than capillary blood glucose, and physiological lag can become more pronounced during rapidly changing glycaemia. [16] This distinction is clinically relevant when treatment decisions are based on a single sensor value rather than the trend and clinical context.

The analytical performance of CGM has improved with newer sensor generations, but accuracy estimates vary across devices, study designs, glucose ranges, and inpatient conditions. Measures such as mean absolute relative difference (MARD) are useful for device evaluation but should not be interpreted as a universal threshold for hospital use. [1,17] The available literature therefore does not support the blanket statement that current-generation CGM systems generally have MARD <10% in hospitalized patients. Instead, accuracy should be interpreted as device- and context-specific, particularly in patients with altered perfusion or rapidly changing glucose concentrations.

Inpatient conditions may adversely affect sensor performance, including hypotension, impaired peripheral perfusion, oedema,

dehydration, hypoxia, severe anaemia, and rapidly changing glucose concentrations. Medication-related interference is also sensor-specific and should be assessed using current manufacturer instructions and institutional protocols. [18]

Because CGM values may be affected by physiological lag, sensor malfunction, interference, or conditions that alter interstitial glucose dynamics, professional guidance recommends that CGM be used as an adjunct to POC monitoring rather than as a universal replacement. Confirmatory POC testing is particularly appropriate when sensor readings are inconsistent with the clinical presentation, during suspected sensor malfunction or rapidly changing glucose levels, and before selected high-risk therapeutic decisions. [1,6-8]

Accordingly, CGM can provide clinically useful continuous surveillance in selected non-ICU inpatients, but the evidence does not justify describing it as uniformly safe or reliable across all hospitalized adults. Safety depends on appropriate patient selection, device-specific limitations, staff competency, institutional protocols, and access to confirmatory POC testing.

Implementation of Continuous Glucose Monitoring in Clinical Practice

Successful implementation of CGM in non-ICU wards requires standardized institutional protocols covering patient eligibility, sensor placement and maintenance, documentation, alarm management, interpretation of trend arrows, data review responsibilities, and indications for confirmatory POC testing. [1,8,15]

Implementation evidence suggests that the technology is most useful when embedded in a clearly defined care pathway rather than introduced as an isolated device.

Patient selection is critical. Current guidance supports consideration of CGM in selected non-critically ill adults, particularly those receiving insulin and those in whom hypoglycaemia or glycaemic variability is a concern. Conversely, severe haemodynamic instability, impaired peripheral perfusion, extensive oedema, and other conditions that may compromise sensor performance warrant closer reliance on conventional POC testing. [1,6-8]

Healthcare professionals require competency in sensor use, interpretation of trends, recognition of device limitations, alarm management, troubleshooting, and identification of situations requiring confirmatory blood glucose testing. [1,8,15]

Integration with electronic health records and hospital information systems may improve documentation and communication, but interoperability remains inconsistent across CGM platforms and institutions. [14,15] Workflow design should also address who reviews CGM data, how often it is reviewed, how alarms are escalated, and how CGM-derived information is incorporated into insulin decisions.

Barriers to broader adoption include acquisition and consumable costs, reimbursement uncertainty, staff training, information-technology requirements, regulatory considerations, interoperability, and the need for local protocols. [15] These implementation constraints mean that evidence of device efficacy alone is insufficient to establish routine hospital-wide adoption.

Economic Considerations, Guideline Recommendations, and Future Directions

The economic value of inpatient CGM remains uncertain. Costs include sensors, receivers or compatible devices, software, staff training, and information-technology infrastructure. Potential savings from fewer bedside measurements, prevention of glycaemic events, or more efficient care are plausible, but evidence from comprehensive prospective cost-effectiveness studies remain limited. [13,15] Economic evaluations should therefore report both implementation costs and downstream clinical/resource outcomes and should account for differences between health systems.

Guidelines and consensus documents increasingly recognize a role for CGM in

selected hospitalized adults, but their recommendations emphasize institutional protocols and continued POC testing when clinically indicated. [1,6-8] These documents should be distinguished from RCTs: they provide expert and guideline-level recommendations based on the evolving evidence rather than direct estimates of treatment effect.

Important evidence gaps remain. Future multicenter RCTs should evaluate patient-centred outcomes such as severe hypoglycaemia, length of stay, readmission, insulin-related adverse events, mortality, patient experience, and resource use. Studies should also use standardized definitions of time in range, hypoglycaemia, glycaemic variability, sensor accuracy, and clinically meaningful outcomes to improve comparability. Cost-effectiveness analyses should be conducted alongside pragmatic trials and should explicitly examine patient selection and implementation intensity.

Future research should also evaluate interoperability, alarm burden, staffing models, remote review, and algorithm-assisted decision support. The key research question is not simply whether CGM can replace finger-stick measurements, but which hospitalized patients benefit from adding continuous trend information to POC monitoring and under what workflow and safety conditions.

CONCLUSION

CGM is a promising adjunct to POC glucose monitoring for appropriately selected adults in non-ICU hospital wards. Randomized evidence supports improvement in several glycaemic metrics when CGM is added to POC monitoring, while observational and implementation studies provide complementary evidence on feasibility and workflow. However, evidence for mortality, length of stay, readmission, and cost-effectiveness remains limited, and sensor performance is context-dependent. CGM should therefore be implemented within standardized institutional protocols, with trained staff and confirmatory POC testing when clinically indicated. Current evidence supports CGM primarily as an adjunct—not a replacement—for POC monitoring, and broader routine adoption should await stronger evidence on patient-centred outcomes, implementation, and economic value.

Declaration

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