Inpatient use of Continuous Glucose Monitors

Guideline Supplement – June 2024



**Inpatient use of Continue Glucose Monitors Guideline Supplement**

Published by the State of Queensland (Queensland Health), June 2024



This document is licensed under a Creative Commons Attribution 3.0 Australia licence. To view a copy of this licence, visit creativecommons.org/licenses/by/3.0/au

© State of Queensland (Queensland Health) 24

You are free to copy, communicate and adapt the work, as long as you attribute the State of Queensland (Queensland Health).

For more information contact:
Queensland Diabetes Network, Health Improvement Unit, Department of Health, GPO Box 48, Brisbane QLD 4001, email QldDiabetesNetwork@health.qld.gov.au

An electronic version of this document is available at www.insert.website.here.com

**Disclaimer:**

The content presented in this publication is distributed by the Queensland Government as an information source only. The State of Queensland makes no statements, representations or warranties about the accuracy, completeness or reliability of any information contained in this publication. The State of Queensland disclaims all responsibility and all liability (including without limitation for liability in negligence for all expenses, losses, damages and costs you might incur as a result of the information being inaccurate or incomplete in any way, and for any reason reliance was placed on such information.

#

# General

Continuous Glucose Monitors (CGM) are increasingly being utilised by People with Diabetes (PWD) as part of their routine diabetes management in the community. In certain clinical circumstances, it may be beneficial for CGM use to be continued in hospital.(1)

**Scope**

|  |
| --- |
| Scope Framework |
| Population | Adult inpatients using CGM |
| Purpose | Develop an evidence-based informed clinical guide to support decision making in relation to use of CGM amongst hospitalised adults with diabetes |
| Outcome | Support identification of: * Scenarios suitable for continued wear and interpretation of CGM
* Scenarios in which wear and use of CGM is not recommended
* Responsibilities for clinical staff caring for those using CGM and recommended clinical workflow
* Patient or caregiver responsibilities for managing a CGM in hospital
 |
| Exclusions | Exclusions to the scope include:* Initiation of CGM for hospitalised PwD
* Insulin pump including CGM connected insulin pumps
* Self-management of diabetes in hospital
* Routine care of diabetes in hospital
* People without diabetes who are using CGM
 |

**Clinical Questions**

The following clinical questions were generated to inform the guideline scope and purpose:

|  |  |
| --- | --- |
| Clinical Questions | Subgroup Membership |
| Who are potential suitable candidates for continued use of CGM in hospital?What contraindications are there for continued CGM use in hospital? | Dr Anish Menon (co-lead)Emma Owers(co-lead)Usha ChandraDr Jade Eccles-Smith  | Joseph MarchisellaKaren BraggDr Catherine StirzakerAlison Cunnington |
| What is the clinical workflow and responsibilities forpatient and caregivers, nursing and medical staffcaring for a person using CGM in hospital? | Kerry Porter (lead)Dr Hannah ReynoldsDr Alexander RobinsonAbby YuTracey Newton | Joyce MostralesKalli HardsPaul HassedJoanne Voll |
| What are the system requirements for hospitals following these guidelines?* What educational resources are required for clinical staff and PWD using CGM in hospital?
* What, if any, patient agreement may be required for use of CGM in hospital?
* How is an individuals history of hypoglycaemia recognised when considering reporting for hospital acquired hypoglycaemia?
 | Dr Benjamin Sly (sub-group and overall lead)Jenna Newton (project coordinator)Alison BarryAnnette Keid |

#### Literature search strategy

Recent internationally endorsed guidelines and supporting publications were firstly reviewed, their recommendations are summarised below in Table 1.

**(1)** Management of Hyperglycemia in Hospitalized Adult Patients in Non-Critical Care Settings: An Endocrine Society Clinical Practice Guideline. J Clin Endocrinol Metab. 2022

(2) A Systematic Review Supporting the Endocrine Society Clinical Practice Guideline for the Management of Hyperglycemia in Adults Hospitalized for Noncritical Illness or Undergoing Elective Surgical Procedures. J Clin Endocrinol Metab. 2022

(3) Continuous Glucose Monitoring Within Hospital: A Scoping Review and Summary of Guidelines From the Joint British Diabetes Societies for Inpatient Care. Journal of Diabetes Science and Technology. 2022

(4) Continuous Glucose Monitors and Automated Insulin Dosing Systems in the Hospital Consensus Guideline. Diabetes Technology Society. J Diabetes Sci Technol. 2020

(5) Diabetes Care in the Hospital: Standards of Care in Diabetes-2023. Diabetes Care. 2023

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **Endocrine Society (1)** | **Joint British Diabetes Societies for Inpatient Care(3)** | **Diabetes Technology Society(4)**  | **American Diabetes Association(5)** |
| **General ward patients** | CGM use recommended for people with diabetes on insulin and at high risk of hypoglycaemia. This recommendation does not apply in situations where CGM may not be accurate. | CGM use endorsed | CGM use endorsed | Continued use of CGM endorsed. Although POC CBG remains the approved method for glucose monitoring and insulin dosing. |
| **ICU/Critically Ill** | Not recommended | Not recommended | Not recommended | No recommendation provided |
| **Sepsis** | Not recommended | Not recommended | Not recommended | No recommendation provided |
| **CKD including dialysis** | No recommendation provided | No recommendation provided  | Not recommended in setting of rapid fluid/electrolyte shifts | No recommendation provided |
| **Hyperglycaemic Emergencies** | Not recommended | Not recommended | Not recommended | No recommendation provided |
| **End of life** | No recommendation provided | No recommendation provided | No recommendation provided | No recommendation provided |

Table 1. Inpatient CGM Guideline Literature Summary

Additional literature review to explore additional studies in the below specific areas were undertaken with the following listed studies helpful in determining the recommendations of the guidelines.

**CGM use in chronic kidney disease**

**(6)** **Frankel AH et al. Management of adults with diabetes on dialysis: Summary of recommendations of the Joint British Diabetes Societies guidelines 2022.**

**Summary of recommendations:**

* People with diabetes on dialysis should be offered CGM if meeting national criteria.
* People with diabetes on dialysis with recurrent hypoglycaemia or hypoglycaemia unawareness should be offered CGM.
* Long term CGM should be considered in people with diabetes on insulin/sulfonylurea and on dialysis
* Short term CGM use should be considered for people with diabetes on dialysis who do not meet national criteria if high burden of hypoglycaemia or hyperglycaemia.
* No specific guidance on inpatient setting provided.

**(7)** **Hissa et al. Use of continuous glucose monitoring system in patients with type 2 mellitus diabetic during hemodialysis treatment.** **Diabetol Metab Syndr 2021**

* Design: Freestyle Libre accuracy compared with POC CBG in 13 people with T2DM on haemodialysis.
* Key Results: 89.6% of CGM readings were in Clarke Error Grid Zone A+B. CGM accuracy deteriorated with CGM duration. Pre dialysis MARD range from 9.4% - 23.6% depending on duration of CGM. Post-dialysis MARD range from 20.1 – 36.4% depending on duration of CGM.

**(8) Toyoda et al. Assessment of the accuracy of an intermittent-scanning continuous glucose monitoring device in patients with type 2 diabetes mellitus undergoing hemodialysis (AIDT2H) study. Ther Apher Dial 2021.**

* Design: Freestyle Libre accuracy compared with POC CBG in 41 people with T2DM on haemodialysis.
* Key Results: MARD 23.4%, CGM measures were significantly lower than POC CBG measures. The accuracy deteriorated with duration of use. Clarke Error Grid Analysis showed 99% in Zone A and B.
* **Recommendation:** Insufficient accuracy necessitates adjunct use of Freestyle Libre with POC CBG in patients on haemodialysis.

**(9) Villard et al. Accuracy of a Factory-Calibrated Continuous Glucose Monitor in Individuals With Diabetes on Hemodialysis. Diabetes Care 2022.**

* Design: Accuracy of Dexcom G6-Pro CGM values were compared with POC venous glucose levels taken on dialysis and POC CBG monitoring for 20 outpatients with diabetes.
* Key results: The mean absolute relative difference of the CGM was 13.8% and 14.4%, when compared with self-monitored POC CBG and on venous blood glucose measures.

**CGM use in perioperative period**

**(10) Sweeney et al. Use of a Continuous Glucose Monitoring System in High-Risk Hospitalized Noncritically Ill Patients With Diabetes After Cardiac Surgery and During Their Transition of Care From the Intensive Care Unit During COVID-19: A Pilot Study. Endocr Pract 2022**

* Design: Dexcom G6 accuracy compared with POC CBG in patients with diabetes admitted to general ward following coronary artery bypass graft surgery.
* Key Results: Overall MARD between point-of-care and CGM measurements was 14.80%; 12.13% for those with eGFR >20 and 21.27% with eGFR <20. 97% glucose values were in Clarke error grid zones A+B.

**(11) Perez-Guzman et al. Continuous Glucose Monitoring in the Operating Room and Cardiac Intensive Care Unit. Diabetes Care 2021**

* Design: Accuracy of Dexcom G6 in 15 adults without diabetes undergoing coronary artery bypass graft surgery.
* Key results: Overall MARD comparing point-of-care and CGM values was 12.9%, Clarke Error Grid analysis showed 98.6% of glucose values zones A and B. Intermittent signal loss was common intraoperatively. CGM was less accurate post operatively.

**(12) Triplya et al. Performance of a factory-calibrated, real-time continuous glucose monitoring system during elective abdominal surgery. Diabetes Obes Metab 2020 Vol. 22 Issue 9 Pages 1678-1682**

* Design: Accuracy of Dexcom G6 compared with POC CBG during elective abdominal surgery in 20 patients.
* Key results: Perioperative MARD 12.7% ± 8.7%, CGM overestimated reference glucose by 1.1 ± 0.8 mmol/L. Clarke error grid analysis 99.2% in zones A or B.

**CGM use in critically ill**

**(13) Faulds et al. Implementation of Continuous Glucose Monitoring in Critical Care: A Scoping Review. Curr Diab Rep 2023 Pages 1-19**

* Design: Review of 16 studies reviewing use of CGM in intensive care settings including 4 RCTs, 7 retrospective cohort studies, 3 prospective cohort studies, 1 quasi-experimental, 1 qualitative design
* Key Results: MARD (7 studies) ranged from 7.5% - 15.3%, Clark Error Grid Analysis (7 studies) all showing >75% in zone A, reduction in POC CBG measures (7 studies) 33 – 71%.

**(14) Price et al. Reliability of Inpatient CGM: Comparison to Standard of Care. J Diabetes Sci Technol. 2023**

* Design: Retrospective cohort study comparing blinded Freestyle LibrePro and POC CBG for 36 inpatients treated with basal bolus insulin (BBT) or IV Insulin (IVI) including 16 patients admitted with DKA.
* Key Results:
	+ IVI: MARD 19.6%, BBT: MARD 24.6%. CGM consistently reported lower glucose values than POC CBG in the majority of paired values (BBT arm mean difference = 44.8 mg/dL, IVI mean difference = 19.7 mg/dL).
	+ The insulin dosing difference in BBT group was 1.34 units and 0.74 units in IVI.

**CGM use in pregnancy**

**(15) Rudland et al. ADIPS 2020 guideline for pre-existing diabetes and pregnancy. Aust N Z J Obstet Gynaecol. 2020**

**Summary of recommendations:**

* During pregnancy, CGM can predict and detect asymptomatic hypoglycaemia and post-prandial peaks which may not be detected by POC CBG.
* This may be particularly useful for pregnant women with unstable blood glucose levels, suspected/undetected hypoglycaemia, previous severe hypoglycaemia, fear of hypoglycaemia and impaired awareness of hypoglycaemia.

**(16) Dashora et al. Managing hyperglycaemia during antenatal steroid administration, labour and birth in pregnant women with diabetes - an updated guideline from the Joint British Diabetes Society for Inpatient Care. Diabet Med. 2022**

**Summary of recommendations:**

* Glucose levels, either POC CBG or CGM glucose levels, should be measured at least hourly from the onset of established labour, artificial rupture of membranes or admission for elective caesarean section.
* If intrapartum glucose levels are higher than 7.0 or 8.0 mmol/L on two consecutive occasions, variable rate IV insulin is recommended. Hourly capillary blood glucose rather than CGM glucose measurements should be used to adjust IV insulin rate.

**(17) Cordua et al. Real-time continuous glucose monitoring during labour and delivery in women with Type 1 diabetes - observations from a randomized controlled trial. Diabet Med. 2013.**

* Design: Randomised trial in which pregnant women with Type 1 diabetes were randomized to CGM + POC CBG (n=60) or POC CBG monitoring alone (n=59)
* Key Results: 37% of infants developed neonatal hypoglycaemia in CGM + POC CBG cohort vs. 46% infants in the control arm (P = 0.45).

**CGM use during medical imaging**

**(18) Migdal et al. Accuracy and Precision of Continuous Glucose Monitoring in Hospitalized Patients Undergoing Radiology Procedures. J Diabetes Sci Technol 2020**

* Design: Retrospective analysis of Dexcom G6 data after radiology procedures x-rays, *n* = 28; CT scan, *n* = 13; catheterisation/ angiography, *n* = 8) without lead apron protection compared with POC CBG.
* Key Results: MARD 13.3% pre-imaging and 12.7% post-imaging. Clarke Error Grid analysis showed 98.1% of glucoses falling into Zones A and B pre-imaging and 99.7% post-imaging

**CGM use in palliative care**

No dedicated studies

**Additional studies of relevance**

**(19) Davis et al. Accuracy of Dexcom G6 Continuous Glucose Monitoring in Non-Critically Ill Hospitalized Patients With Diabetes. Diabetes Care. 2021**

* Design: Retrospective matched-pair Dexcom G6 and POC CBG from 218 patients (96% with Type 2 Diabetes) admitted under general medicine and surgery were analysed.
* Key Results: The overall MARD was 12.8%, and median ARD was 10.1%. Clarkes Error Grid analysis showed 98.7% of all values in zones A and B. MARD and median ARD were higher in the case of hypoglycaemia and severe anaemia.

**(20) Spanakis et al. Continuous Glucose Monitoring-Guided Insulin Administration in Hospitalized Patients With Diabetes: A Randomized Clinical Trial. Diabetes Care. 2022**

* Design: Randomised trial comparing glucose metrics for 185 hospitalised patients using a basal bolus regimen and either POC CBG or Dexcom G6 to guide insulin dosing.
* Key Results: There were no significant differences in time in range (54.51% ± 27.72 vs. 48.64% ± 24.25; P = 0.14), mean daily glucose (10.16mmol/L ± 2.2mmol/L vs. 10.37mmol/L ± 2.2mmol/L; P = 0.36), or percent of patients with CGM values <3.9mmol/L (36% vs. 39%; P = 0.68) or <3.0mmol/L (14 vs. 24%; P = 0.12) between the CGM-guided and POC CBG groups. Among patients with one or more hypoglycaemic events, compared with POC, the CGM group experienced significantly less recurrent hypoglycaemia and a lower overall time below range (<3.9mmol/L)

**(21) Wright et al. Accuracy of Continuous Glucose Monitors for Inpatient Diabetes Management. J Diabetes Sci Technol. 2022**

* Design: Retrospective analysis of Freestyle Libre 1 and Freestyle Libre 2 CGM accuracy and safety in 77 non-critically ill inpatients comparing CGM values to POC CBG.
* Key Results: MARD Freestyle Libre 1 21.4%, Freestyle Libre 2 17.7%, Clarkes Error Grid Analysis of all CGM values showed 98.8% of paired values fell within acceptable zones A and B. there was no significant change in accuracy over sensor duration with Freestyle Libre 2

**(22) Sopfe et al. Safety and Accuracy of Factory-Calibrated Continuous Glucose Monitoring in Pediatric Patients Undergoing Hematopoietic Stem Cell Transplantation. Diabetes Technol Ther. 2020**

* Design: Prospective observational study comparing Abbott Freestyle Libre Pro and POC CBG, in 29 paediatric patients (mean age 13.1 years) undergoing Hematopoietic stem cell transplantation.
* Key Results: Paired serum-sensor values demonstrated a mean absolute relative difference of 20%±14%. Clarke Error Grid analysis showing 99% of pairs in Zones A+B.

**(23) Baker et al. Practical implementation of remote continuous glucose monitoring in hospitalized patients with diabetes. Am J Health Syst Pharm 2022**

* Design: Accuracy of Dexcom G6 compared with CBG amongst 10 patients with COVID.
* Key Results: MARD 10.3%, Clarke error grid 99.2% in Zone A+B. Insulin dose recommendations using CGM values would have differed in 25% of insulin doses (1-3 units)

**Consultation**

Major consultative and development processes occurred between January 2023 and January 2024.

|  |  |
| --- | --- |
| Process | Activity |
| Clinical Lead | Dr Benjamin Sly |
| Working party and subgroup leads | Dr Benjamin Sly, Dr Anish Menon, Emma Owers, Kerry Porter, Jenna Newton |
| Consumer participation | Paul Hassed (dedicated consumer) and a number of members of the working party who participated both in a clinical and consumer perspective |
| Statewide consultation | The working group was diverse in representation from backgrounds including:Endocrinology, Anaesthetics, Diabetes Education, Dietetics, Pharmacy, Nursing, ConsumerPrimary clinical sites includingPrincess Alexandra, Royal Brisbane and Womens, Logan, Ipswich, Caboolture, Bundaberg, Queensland Childrens and Toowoomba Hospitals The guidelines were reviewed and endorsed by the Queensland Diabetes Clinical Network |
| National consultation | The guidelines were presented to the Australian Diabetes Society Inpatient Committee |

#### Endorsement

Queensland Diabetes Network

Australian Diabetes Society

#### Citation

**Implementation**

This guideline is applicable to all Queensland Health acute care facilities. It can be downloaded in PDF format (link)

**Guideline resources**

**The following guideline components are provided as separate resources**

* Short Guide
* Guideline supplement with supportive evidence
* Basic CGM information for clinical staff
* Patient agreement outlining responsibilities for CGM use in hospital

**Implementation measures**

Suggested activities to assist implementation of the guideline are outlined below

# References

1. Korytkowski MT, Muniyappa R, Antinori-Lent K, Donihi AC, Drincic AT, Hirsch IB, et al. Management of Hyperglycemia in Hospitalized Adult Patients in Non-Critical Care Settings: An Endocrine Society Clinical Practice Guideline. J Clin Endocrinol Metab. 2022;107(8):2101-28.

2. Seisa MO, Saadi S, Nayfeh T, Muthusamy K, Shah SH, Firwana M, et al. A Systematic Review Supporting the Endocrine Society Clinical Practice Guideline for the Management of Hyperglycemia in Adults Hospitalized for Noncritical Illness or Undergoing Elective Surgical Procedures. J Clin Endocrinol Metab. 2022;107(8):2139-47.

3. Avari P, Lumb A, Flanagan D, Rayman G, Misra S, Dhatariya K, et al. Continuous Glucose Monitoring Within Hospital: A Scoping Review and Summary of Guidelines From the Joint British Diabetes Societies for Inpatient Care. Journal of Diabetes Science and Technology. 2022:19322968221137338.

4. Galindo RJ, Umpierrez GE, Rushakoff RJ, Basu A, Lohnes S, Nichols JH, et al. Continuous Glucose Monitors and Automated Insulin Dosing Systems in the Hospital Consensus Guideline. J Diabetes Sci Technol. 2020;14(6):1035-64.

5. ElSayed NA, Aleppo G, Aroda VR, Bannuru RR, Brown FM, Bruemmer D, et al. 16. Diabetes Care in the Hospital: Standards of Care in Diabetes-2023. Diabetes Care. 2023;46(Suppl 1):S267-S78.

6. Frankel AH, Wahba M, Ashworth V, Bedi R, Berrington R, Buckley M, et al. Management of adults with diabetes on dialysis: Summary of recommendations of the Joint British Diabetes Societies guidelines 2022. Diabet Med. 2023;40(4):e15027.

7. Hissa MRN, Hissa PNG, Guimarães SB, Hissa MN. Use of continuous glucose monitoring system in patients with type 2 mellitus diabetic during hemodialysis treatment. Diabetol Metab Syndr. 2021;13(1):104.

8. Toyoda M, Murata T, Saito N, Kimura M, Takahashi H, Ishida N, et al. Assessment of the accuracy of an intermittent-scanning continuous glucose monitoring device in patients with type 2 diabetes mellitus undergoing hemodialysis (AIDT2H) study. Ther Apher Dial. 2021;25(5):586-94.

9. Villard O, Breton MD, Rao S, Voelmle MK, Fuller MR, Myers HE, et al. Accuracy of a Factory-Calibrated Continuous Glucose Monitor in Individuals With Diabetes on Hemodialysis. Diabetes Care. 2022;45(7):1666-9.

10. Sweeney AT, Pena S, Sandeep J, Hernandez B, Chen Y, Breeze JL, et al. Use of a Continuous Glucose Monitoring System in High-Risk Hospitalized Noncritically Ill Patients With Diabetes After Cardiac Surgery and During Their Transition of Care From the Intensive Care Unit During COVID-19: A Pilot Study. Endocr Pract. 2022;28(6):615-21.

11. Perez-Guzman MC, Duggan E, Gibanica S, Cardona S, Corujo-Rodriguez A, Faloye A, et al. Continuous Glucose Monitoring in the Operating Room and Cardiac Intensive Care Unit. Diabetes Care. 2021;44(3):e50-e2.

12. Tripyla A, Herzig D, Joachim D, Nakas CT, Amiet F, Andreou A, et al. Performance of a factory-calibrated, real-time continuous glucose monitoring system during elective abdominal surgery. Diabetes Obes Metab. 2020;22(9):1678-82.

13. Faulds ER, Dungan KM, McNett M. Implementation of Continuous Glucose Monitoring in Critical Care: A Scoping Review. Curr Diab Rep. 2023:1-19.

14. Price C, Ditton G, Russell GB, Aloi J. Reliability of Inpatient CGM: Comparison to Standard of Care. J Diabetes Sci Technol. 2023;17(2):329-35.

15. Rudland VL, Price SAL, Hughes R, Barrett HL, Lagstrom J, Porter C, et al. ADIPS 2020 guideline for pre-existing diabetes and pregnancy. Aust N Z J Obstet Gynaecol. 2020;60(6):E18-E52.

16. Dashora U, Levy N, Dhatariya K, Willer N, Castro E, Murphy HR, et al. Managing hyperglycaemia during antenatal steroid administration, labour and birth in pregnant women with diabetes - an updated guideline from the Joint British Diabetes Society for Inpatient Care. Diabet Med. 2022;39(2):e14744.

17. Cordua S, Secher AL, Ringholm L, Damm P, Mathiesen ER. Real-time continuous glucose monitoring during labour and delivery in women with Type 1 diabetes - observations from a randomized controlled trial. Diabet Med. 2013;30(11):1374-81.

18. Migdal AL, Spanakis EK, Galindo RJ, Davis G, Singh LG, Satyarengga M, et al. Accuracy and Precision of Continuous Glucose Monitoring in Hospitalized Patients Undergoing Radiology Procedures. J Diabetes Sci Technol. 2020;14(6):1135-6.

19. Davis GM, Spanakis EK, Migdal AL, Singh LG, Albury B, Urrutia MA, et al. Accuracy of Dexcom G6 Continuous Glucose Monitoring in Non-Critically Ill Hospitalized Patients With Diabetes. Diabetes Care. 2021;44(7):1641-6.

20. Spanakis EK, Urrutia A, Galindo RJ, Vellanki P, Migdal AL, Davis G, et al. Continuous Glucose Monitoring-Guided Insulin Administration in Hospitalized Patients With Diabetes: A Randomized Clinical Trial. Diabetes Care. 2022;45(10):2369-75.

21. Wright JJ, Williams AJ, Friedman SB, Weaver RG, Williams JM, Hodge E, et al. Accuracy of Continuous Glucose Monitors for Inpatient Diabetes Management. J Diabetes Sci Technol. 2022:19322968221076562.

22. Sopfe J, Vigers T, Pyle L, Giller RH, Forlenza GP. Safety and Accuracy of Factory-Calibrated Continuous Glucose Monitoring in Pediatric Patients Undergoing Hematopoietic Stem Cell Transplantation. Diabetes Technol Ther. 2020;22(10):727-33.

23. Baker M, Musselman ME, Rogers R, Hellman R. Practical implementation of remote continuous glucose monitoring in hospitalized patients with diabetes. Am J Health Syst Pharm. 2022;79(6):452-8.