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Nurses' perceptions of continuous glucose monitoring in pediatric high-dependency care: a single-center survey of workflow and safety during management of an infant with hyperinsulinemic hypoglycemia

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Abstract

***Background*:** Dysglycemia is associated with increased morbidity and mortality in critically ill pediatric patients. Continuous glucose monitoring (CGM) offers real-time glucose trend data, addressing limitations of point-of-care (POC) testing, such as intermittent readings and high workload. However, successful implementation of CGM in high-dependency (HD) pediatric care depends significantly on nurses' perceptions and acceptance, which could better manage nursing workload.

***Objective*:** This study explores nurses' perceptions of CGM in a pediatric HD setting, focusing on factors that influence CGM adoption for workload management, using a case formulation framework, including predisposing, perpetuating, precipitating, and protective factors.

***Methods*:** A single-center study was conducted at KK Women's and Children's Hospital, involving 45 HD nurses who took part in a validated 20-item survey. Training on CGM implementation and guidelines was provided, and descriptive statistics were used to analyze survey responses. A specific case of an infant with hyperinsulinemic hypoglycemia (HH) was included to illustrate CGM's clinical application. The study was conducted in accordance with institutional guidelines, ensuring confidentiality of patient and nurse data.

***Results*:** Most nurses (86%) reported that CGM was easy to use and reduced their workload compared to POC testing. In addition, 88% of nurses agreed that CGM, when combined with POC testing, enhanced patient safety. Despite limited familiarity with CGM prior to implementation (37% reported no prior experience), 86% of nurses felt comfortable using CGM after training, which was primarily delivered through peer-led handovers. Barriers to adoption included challenges with calibration protocols and perceived accuracy (54% reported CGM readings as accurate). Overall, 82% of nurses recommended CGM for continued use in HD care.

***Conclusion*:** The CGM is perceived positively by nurses for its ability to enhance patient safety, improve workflow efficiency, and reduce workload in pediatric HD settings. However, successful implementation requires structured training, clear guidelines, and ongoing support to address barriers such as limited familiarity and calibration challenges. Future research should evaluate CGM's cost-effectiveness, clinical outcomes, and long-term impact on glycemic control in acute inpatient pediatric care.

Keywords: *continuous glucose monitoring*; *hyperinsulinemic hypoglycemia*; *nursing workload*

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Dysglycemia, encompassing both hyperglycemia and hypoglycemia, is a critical concern in pediatric acute care settings due to its association with increased morbidity and mortality. Hyperglycemia and glucose variability are strong predictors of poor outcomes, including prolonged hospital stays, higher rates of nosocomial infections, and increased mortality in pediatric intensive care units.[1,2] The risk of mortality rises with the severity and duration of hyperglycemia, as well as increased glucose variability.[3] Hypoglycemia, although less common, could lead to adverse outcomes, including neurodevelopmental impairment and higher mortality rates.[4] Point-of-care (POC) glucose monitoring via capillary glucose sampling used in pediatric acute care settings has its

limitations, particularly in critically ill children. The accuracy of POC testing can be compromised by factors such as abnormal hematocrit, oxygen tension, and vasopressor therapy, which are common in high-dependency (HD) units.[5,6] In addition, POC devices might be less reliable at extreme glucose levels, posing risks for inappropriate clinical decisions.[6] Conventional POC monitoring, with its intermittent nature, can also miss significant glycemic excursions, including postprandial hyperglycemia and nocturnal hypoglycemia.[7] HD care refers to specialised inpatient care for patients requiring close monitoring and nursing support that exceeds general ward care but does not require intensive care admission.

Continuous glucose monitoring (CGM) has appeared as a promising tool to overcome the limitations of POC testing in pediatric acute care. By providing real-time glucose trend data and system alerts for hypoglycemia and hyperglycemia, CGM enables prompt clinical interventions with improving patient safety[8] at managing diabetic ketoacidosis[9,10] and reducing hypoglycemia incidence, glucose variability, and overall mortality in critically ill patients.[10] While CGM accuracy may be slightly lower in critically ill children compared to adults,[12] the reduction in nursing workload and enhanced glycemic control underscore its potential as a valuable adjunct to POC testing.[8]

The successful implementation of CGM in pediatric acute care depends significantly on nurses' perceptions and acceptance. Studies have shown that nurses generally view CGM positively, citing improved patient care, reduced workload, and enhanced safety as key benefits.[13] Factors influencing CGM adoption include the practice setting, patient demographics, and availability of resources. However, barriers such as technical challenges, complex setup processes, system integration, and documentation issues may hinder its adoption.[13,14] Proper education, ongoing support, and clear protocols are essential to facilitate CGM integration and optimize its use in HD units.[15]

This study aims to report nurses' perceptions of CGM in a pediatric HD unit using a case formulation framework reporting from a clinical case of an infant with hyperinsulinemic hypoglycemia (HH). HH is a disorder characterized by inappropriate insulin secretion resulting in recurrent hypoglycemia. By examining factors that predispose, precipitate, perpetuate, and protect the use of CGM, this study seeks to find strategies to enhance its implementation and acceptance in acute care settings. Findings from this study will provide insights into the integration of CGM in pediatric care, with applications for improving nursing workflow, patient outcomes, and glycemic management practices.

Methods

This single-center descriptive cross-sectional survey study was conducted in the Pediatric Medical High Dependency Unit at KK Women's and Children's Hospital, Singapore. The CGM device used was Dexcom G6 on a clinical case in KK Women and Children Hospital as the first infant with HH, a disorder characterized by inappropriate insulin secretion resulting in recurrent hypoglycemia. This infant case was included as an illustrative implementation example to provide clinical context for nursing perceptions of CGM use. The study objective was to evaluate nurses' experiences and perceptions rather than patient clinical outcomes. Consequently, findings reflect nurses' perceptions arising from direct exposure to CGM implementation in this clinical case rather than perceptions of unit-wide CGM use across multiple patients.

Nurses in the HD unit were trained in the use and implementation of CGM devices. Training was delivered by a diabetes nurse educator and included procedural training, such as hands-on instruction on connecting, setting up, and calibrating the CGM device. Nurses received a step-by-step written guide on integrating POC glucose testing with CGM, using a scaffolded approach that involves gradually building knowledge and skills through structured guidance and support to ensure clarity across nursing shifts. A designated nurse-in-charge was updated and given revised guidelines weekly to keep consistency, and direct observational assessments were conducted during shifts to support nursing staff. The CGM system provided real-time glucose trend data, offering alerts for hypo- and hyper-glycemia and reducing reliance on frequent fingerstick tests. Nurses were instructed on interpreting glucose trend arrows and graphs, enabling them to predict glycemic fluctuations and make prompt interventions.

The 20-item survey (Appendix A) was adopted from Faulds et al.[13] and was used without modification to preserve content validity and ease comparison with published findings. Because the original instrument was used in its entirety and the sample size was relatively small (n = 45), additional psychometric testing, including Cronbach's alpha analysis, was not performed in this study. The study team reviewed the survey to ensure contextual relevance to the pediatric HD setting. The case formulation framework including predisposing, precipitating, perpetuating, and protective factors was selected as an implementation-oriented framework to systematically examine factors influencing CGM adoption, usability, sustainability, and acceptance among nurses. This framework allowed exploration of both facilitators and barriers to technology implementation within clinical practice.

The following CGM care protocols were developed for the index case:

- Sensor monitoring: Glucose levels were checked every 3 h (Q3H), with closer monitoring during fluctuations.
- Calibration: POC glucose testing was performed every 12 h (Q12H) to confirm sensor readings, with calibration occurring twice daily.
- Calibration guidelines:

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- Calibrate before milk feeds
- Calibrate only when sensor readings are stable (no fluctuations >1 mmol/L within 1 h)
- Monitor for hypoglycemia (defined as glucose levels < 4 mmol/L)

Ethical considerations

This study involved an anonymous survey of nursing staff about their experiences with CGM implementation in clinical practice. No patient interventions were conducted as part of the study, and no identifiable personal information from either nurses or patients was collected. As the project was conducted as a service evaluation/quality improvement initiative involving anonymous staff feedback, formal Institutional Review Board (IRB) approval was not obtained. Participation was voluntary, completion of the survey implied consent to take part, and all responses were collected anonymously. The infant case was included solely as an illustrative clinical example, and all potentially identifying information was removed to protect patient confidentiality.

Statistical analysis

Survey responses were analyzed using descriptive statistics to summarize the characteristics and perceptions of the 45 participating nurses. Frequencies and percentages were calculated for categorical variables, and results were grouped according to the four case formulation themes: predisposing, perpetuating, precipitating, and protective factors. Positive responses, defined as 'Strongly Agree' or 'Agree', were tabulated for each survey question. All data analyses were conducted using Stata Version 18.

Results

Baseline characteristics

A total of 45 nurses from the pediatric HD unit took part in the survey. Participants reported a mean of 9 years of overall nursing experience, with 64% indicating 0–10 years of experience and 36% having more than 10 years of experience. In terms of HD-specific experience, 66% reported 10 years or less, while 34% had more than 10 years of experience. Most nurses (77%) indicated that they had not started or replaced a CGM sensor previously, with only 23% having done so. Prior familiarity with CGM systems was limited, with 46% of participants describing themselves as 'a little familiar', 37% as 'not familiar', 7% as 'very familiar', and 9% as 'neutral'. 71% of the training on CGM usage was through peer-led shift handovers, followed by instruction from diabetes nurse educators and self-directed online learning (Table 1).

Survey findings on CGM perceptions

Table 2 summarizes nurses' perceptions of CGM, grouped into the following themes: predisposing factors, perpetuating factors, precipitating factors, and protective factors. Positive responses are defined as the proportion of participants who responded with 'strongly agree' or 'agree' to survey items.

Table 1. Baseline characteristics of study participants

Characteristic	Category	*n* (%)
Years of nursing experience	0–5	17 (38)
	6–10	12 (27)
	11–15	7 (16)
	16–20	5 (11)
	> 20	4 (9)
	Mean (SD)	**9.0 (6.1)**
Years in high-dependency (HD) care	0–5	22 (48)
	6–10	8 (18)
	11–15	11 (24)
	16–20	3 (7)
	> 20	1 (2)
	Mean (SD)	**8.5 (5.2)**
Started or replaced a CGM sensor	Yes	10 (22)
	No	35 (78)

Table 2. Nurses' perceptions of continuous glucose monitoring (CGM)

Theme	Survey question	*n* (%)
Predisposing factors	I found it easy to document the CGM values in the electronic medical record.	39 (86)
	I found the process of initially validating the CGM glucose using capillary blood glucose readings easy.	29 (64)
	How familiar were you with CGM systems prior to using it on this patient? ('A little familiar' or more)	24 (53)
Perpetuating factors	I felt comfortable using CGM after receiving training.	39 (86)
	I learned to use CGM from colleagues during nursing handovers.	32 (71)
	I received training on CGM from a diabetes nurse educator.	10 (22)
Precipitating factors	Using CGM along with capillary blood glucose made my patients safer.	40 (88)
	The CGM reduced my workload compared to capillary blood glucose testing.	39 (86)
	Using CGM improved the overall quality of care for my patients.	35 (77)
	I found the CGM glucose readings to be accurate.	24 (54)
Protective factors	I prefer the use of CGM + capillary blood glucose as compared to only using capillary blood glucose.	33 (73)
	How likely are you to recommend the use of CGM to other colleagues? ('Very Likely' or 'Likely')	37 (82)
	I welcome continued use of CGM in high-dependency settings.	39 (86)

Positive responses are defined as 'Strongly Agree', 'Agree'.

Predisposing factors

Nurses were asked about the ease of using CGM in the HD setting. A large majority (86%) reported that documenting CGM values in the electronic medical record was easy. Similarly, 64% of respondents agreed that validating CGM glucose readings against POC tests, as outlined in the provided guidelines, was a straightforward process. Nurses across different experience levels, including those with less than 10 years of HD experience, expressed similar ease in using CGM, indicating that the technology was accessible to staff with varying levels of expertise.

Perpetuating factors

The survey highlighted the level of familiarity and comfort nurses had with CGM before and after its implementation. Before using CGM, 46% of nurses described themselves as 'a little familiar' with the system, and 37% reported being 'not familiar' at all. Despite this, after training and use, 86% of participants indicated that they found CGM devices easy to use. Training on CGM was primarily delivered during nursing shift handovers, with 71% of participants reporting they learned from colleagues in this manner. In addition, 53% of nurses felt adequately trained and prepared to use CGM after receiving initial guidance, and 75% indicated they did not experience significant difficulties during their first time using the device.

Precipitating factors

Nurses recognized the positive impact of CGM on patient care and safety. Eighty-eight percent of respondents agreed or strongly agreed that combining CGM with POC testing made their patients safer. A similar proportion (86%) stated that using CGM reduced their workload compared to relying solely on POC testing, particularly by decreasing the need for frequent fingerstick glucose checks. Moreover, 77% of nurses believed that CGM improved the overall quality of patient care. When asked about the accuracy of CGM readings, 54% of participants reported that the readings were accurate, while others were neutral or unsure, reflecting some variation in confidence regarding the device's reliability.

Protective factors

The combination of POC testing and CGM was preferred by 73% of nurses over using POC testing alone, as this approach was perceived to enhance monitoring accuracy and patient safety. Adherence to the validation guidelines for CGM readings was also rated positively, with 88% of nurses agreeing that following these protocols improved safety outcomes. Support for the continued use of CGM in the HD setting was strong, with 86% of respondents expressing agreement or strong agreement that CGM use should be maintained. Furthermore, 82% of nurses stated they would recommend CGM to their colleagues, indicating a high level of confidence in the benefits of CGM for pediatric acute care.

When asked about the sources of their CGM training, the majority (71%) reported learning from colleagues during shift handovers, while 22% received direct training from diabetes nurse educators. Only a small proportion (7%) self-learned by watching online resources. Despite the initial unfamiliarity with CGM reported by many nurses, the structured approach to training, combined with peer support, appeared to contribute significantly to the successful adoption of CGM in the unit.

Discussion

The inclusion of the infant with HH helps contextualized survey findings as a study exploring nurses' perception of CGM in a pediatric HD unit, focusing on predisposing, perpetuating, precipitating, and protective factors that influence its adoption and use. The findings revealed that most nurses found CGM easy to use, with 86% reporting that documenting CGM values in electronic medical records was straightforward. Despite limited familiarity with CGM prior to implementation, 86% of nurses indicated they were comfortable using the technology following training, which was primarily delivered through peer-led shift handovers. Furthermore, nurses acknowledged the benefits of CGM in enhancing patient safety, with 88% agreeing that CGM use alongside POC testing made patients safer, and 86% reporting reduced workload compared to POC testing alone. However, barriers to CGM adoption were also identified, including limited initial familiarity and challenges with validation protocols, emphasizing the importance of structured training and clear guidelines.

Nurses' perception plays a critical role in the successful adoption of CGM in clinical settings. Consistent with previous research, this study highlights that perceived ease of use and clinical utility are key determinants of nurses' satisfaction and acceptance of new technologies.[16,17] The finding that most nurses in this study found CGM easy to integrate into workflows aligns with evidence suggesting that CGM reduces documentation challenges and simplifies glucose monitoring processes.[13] However, the observation that 37% of nurses reported being unfamiliar with CGM prior to its implementation highlights the need for robust and structured training programs. While peer-to-peer handover training facilitated rapid implementation and knowledge sharing, reliance on informal educational approaches may result in variability in knowledge acquisition. Structured competency-based training programs supported by diabetes nurse educators may improve consistency, confidence, and long-term sustainability of CGM implementation.[18]

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This study also reinforces existing evidence that CGM improves glycemic control and reduces hypoglycemia in pediatric acute care. CGM's ability to provide real-time glucose trend data supports early detection of glycemic fluctuations and prompt clinical interventions, which 88% of nurses in this study identified as a key benefit. These findings align with studies showing that CGM decreases hypoglycemia incidence and improves glucose variability in critically ill patients.[11,19] In addition, the workload reduction reported by 86% of nurses is consistent with prior research showing that CGM decreases the frequency of fingerstick testing, thereby freeing up time for other care activities.[8,20] Despite these advantages, concerns about CGM accuracy, particularly in cases of HH, remain significant, as highlighted by 46% of nurses in this study and supported by previous findings.[21,22]

Only 54% of nurses reported confidence in CGM accuracy, indicating an important implementation challenge. This finding may reflect known limitations of CGM technology in acute care settings, particularly interstitial-to-blood glucose lag during rapidly changing glucose levels, calibration requirements, and limited prior user experience. In our implementation, CGM was used as an adjunct to POC testing rather than a replacement, and twice-daily calibration alongside validation protocols were maintained to enhance safety. The observed uncertainty regarding accuracy reinforces the importance of structured education on CGM interpretation, sensor physiology, and expected discrepancies between CGM and capillary glucose values. Because objective accuracy metrics such as mean absolute relative difference (MARD), Clarke Error Grid analysis, or paired agreement assessments were not collected, future studies should incorporate these measures to better correlate user perceptions with device performance.

Barriers to CGM implementation identified in this study align with existing literature, including challenges related to device setup, frequent calibration requirements, and limited initial familiarity with the technology.[22,23] These findings underscore the need for clear protocols and ongoing support to address these challenges. Nurses emphasized the importance of combining CGM with POC testing during the early stages of implementation, reflecting the utility of hybrid monitoring approaches to ensure patient safety.[13] Furthermore, adherence to validation guidelines was noted as a critical factor in enhancing safety and building confidence in the technology's reliability.

The economic feasibility of CGM adoption in inpatient pediatric care is another important consideration. While CGM systems may have higher initial costs than POC testing, literatures on cost-effectiveness analyses suggest that CGM can reduce overall healthcare expenditures by improving glycemic control and preventing complications.[8,24] Nurses in this study highlighted the workload reduction and improved safety associated with CGM. However, further cost-effectiveness studies are needed to validate these findings and assess their relevance in diverse clinical contexts.[25–28]

Several limitations are identified. Its single-center design limits generalizability to other healthcare systems with differing resources, workflows, and patient populations. The reliance on a survey-based design may have introduced response biases, such as over-reporting of positive experiences, and lacked the nuance that qualitative methods such as interviews or focus groups could provide. Furthermore, the study did not evaluate key clinical outcomes such as hypoglycemia incidence, glycemic variability, or length of hospital stay, which are critical for assessing CGM's broader effectiveness in pediatric acute care. Due to the modest sample size and the aggregated anonymous survey dataset available for analysis, inferential subgroup analyses according to years of experience, prior familiarity with CGM, or training source were not performed. Future studies with larger sample sizes should evaluate factors associated with positive perceptions and successful adoption.

Conclusion

Although survey responses arose from experience with a single index patient, participants evaluated broader workflow and clinical implications of CGM use, which may inform future implementation efforts. Several local contextual factors may have contributed to the favorable perceptions observed in this study. These included support from a dedicated diabetes nurse educator, ongoing supervision by senior nurses, structured implementation guidelines, and a clinical culture supportive of technological innovation. Consequently, while the findings provide useful insights for pediatric HD care, adaptation to local resources, staffing models, and organisational readiness should be considered when applying these findings internationally.

Conflict of interest and funding

The authors declare no competing interests. No specific funding was received for this study.

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Appendix A

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1 Did you care for the patient with a sensor device for continuous glucose monitoring (CGM)?
- Yes
- No

2 For how many years have you been a nurse?
- 0 to 5
- 6 to 10
- 11 to 15
- 16 to 20
- more than 20
- Total

3 For how many years have you worked in the HD?
- 0 to 5
- 6 to 10
- 11 to 15
- 16 to 20
- more than 20

4 Did you start a new sensor or replace a sensor?
- Yes
- No

5 The first time I inserted a sensor I found the process to be difficult.
- Strongly agree
- Agree
- Disagree
- Strongly disagree
- Neither

6 I was able to use the CGM glucose values instead of the point-of-care fingerpricks (i.e. capillary blood glucose)
- Strongly agree
- Agree
- Disagree
- Strongly disagree
- Neither

7 I found the CGM glucose to be accurate.
- Strongly agree
- Agree
- Disagree
- Strongly disagree
- Neither

8 I found the process of initially validating the CGM glucose using capillary blood glucose readings as required by doctors to be easy.
- Strongly agree
- Agree
- Disagree
- Strongly disagree
- Neither

9 I found it easy to document the CGM values in the electronic medical record.
- Agree
- Strongly agree
- Disagree
- Strongly disagree
- Neither

10 The CGM reduced my workload as compared to capillary blood glucose test.
- Strongly agree
- Agree
- Disagree
- Strongly disagree
- Neither

11 I prefer the use of CGM + capillary blood glucose as compared to only using capillary blood glucose.
- Strongly agree
- Agree
- Disagree
- Strongly disagree
- Neither

12 How likely are you to recommend the use of CGM to other colleagues?
- Very likely
- Likely
- Neither
- Unlikely

13 How familiar were you with the CGM systems prior to using it on this patient?
- I am a little familiar
- I am very familiar
- Neither
- Not familiar

14 How did you learn to use the CGM?
- Taught by colleague
- Taught by diabetes Nurse
- Watch online and self-learn

15 I felt well trained and prepared to use the CGM.
- Strongly agree
- Agree
- Disagree
- Strongly disagree
- Neither

16 Using CGM improved the care for my patients.
- Strongly agree
- Agree
- Disagree
- Strongly disagree
- Neither

17 Using CGM along with capillary blood glucose made my patients safer.

Strongly agree

Agree

Disagree

Strongly disagree

Neither

18 I like using CGM in HD for its easy usage.

Strongly agree

Agree

Disagree

Strongly disagree

Neither

19 I welcome continued use of CGM in HD.

Strongly agree

Agree

Disagree

Strongly disagree

Neither

20 Using CGM in the HD seems applicable to patient with hypoglycemia or hyperglycemia.

Strongly agree

Agree

Disagree

Strongly disagree

Neither

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