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# Nurse-led glycemic control protocols in intensive care units: a scoping review

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Nurse-led glycemic management in critical care settings has been demonstrated to reduce the incidence of dysglycemia, including hyperglycemia and hypoglycemia, while stabilizing glycemic variability, contributing to enhanced patient outcomes. This scoping review aimed to identify nurse-led glycemic management protocols in intensive care units, analyze their components (e.g., target glucose range, monitoring frequency, and implementation methods), and evaluate their effectiveness. Seven databases, including PubMed and CINAHL, were searched for studies published between January 2015 and April 2025. Studies were selected using predefined inclusion criteria, and two independent reviewers evaluated methodological quality using the JBI critical appraisal tool. Ultimately, seven quasi-experimental studies were included. Most protocols employed continuous intravenous insulin infusions (n=5), whereas others focused on hypoglycemia management (n=2). The target glucose levels ranged from 100–180 mg/dl, and the monitoring intervals varied from 15 minutes to 4 hours depending on the protocol type. All protocols excluded patients on oral diets and those receiving intermittent enteral nutrition. Four studies used printed guidelines with manual adjustments, whereas three employed computerized decision-support systems. The studies indicated that nurse-led glycemic control management was associated with reductions in both glycemic variability and in the incidence of hyper- and hypoglycemia. These findings highlight the need for evidence-based updates to nurse-led glycemic control protocols in critical care for safe and effective management through a multidisciplinary approach.

**Key Words:** glycemic control; intensive care units; nurse

**Review Article**

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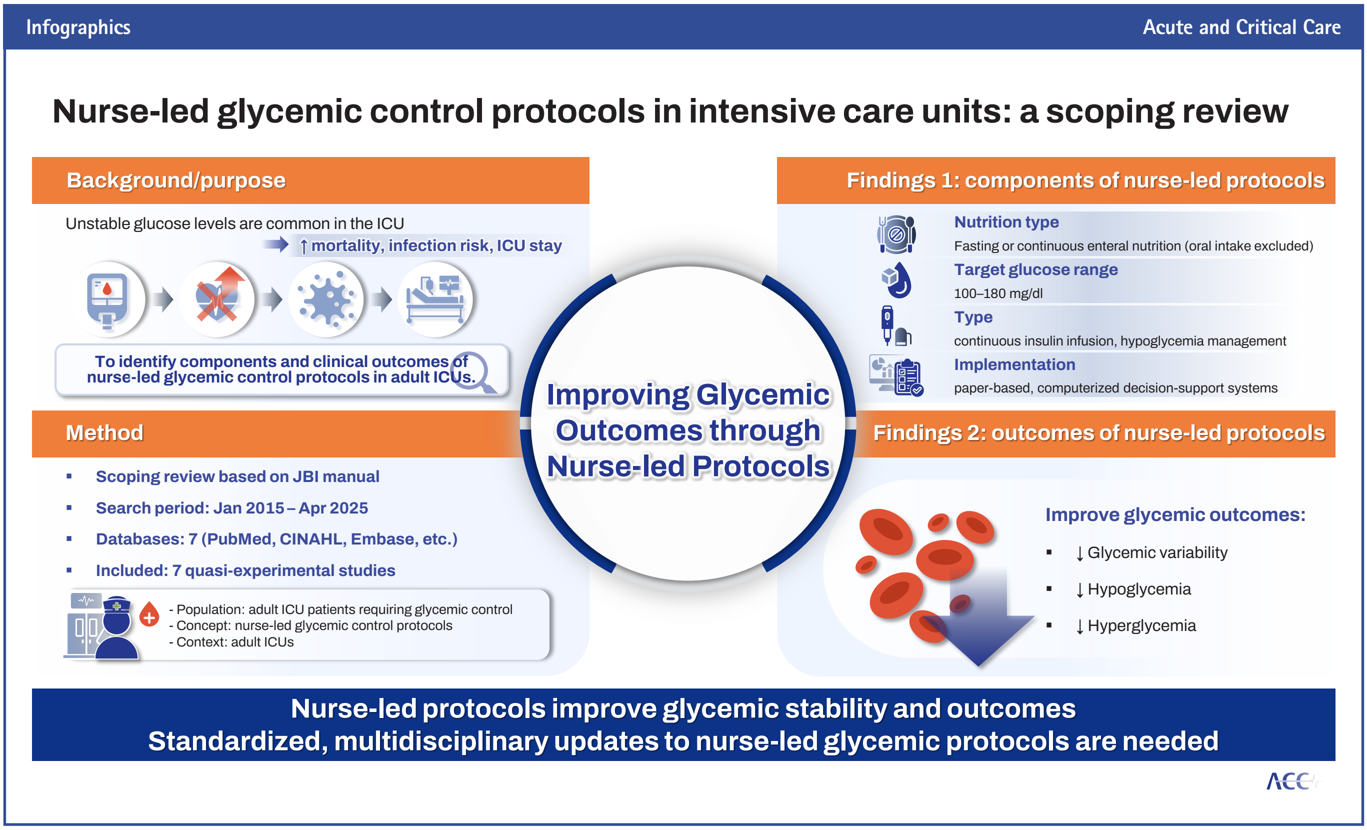
## INTRODUCTION

Critically ill patients experience hyperglycemia regardless of a prior diagnosis of diabetes. This phenomenon, known as stress-induced hyperglycemia, results from various pathophysiological factors, such as acute illness, pharmacologic interventions, surgical stress, systemic inflammation, and altered insulin sensitivity [1]. Furthermore, such patients have an




increased risk of developing hypoglycemia compared with the general patient population [2]. In the intensive care unit (ICU), glycemic instability is further compounded by frequent interruptions in nutritional support, impaired recognition of hypoglycemia resulting from sedation, and the overall complexity of glycemic management. Hypoglycemia and glycemic variability are particularly detrimental, being strongly associated with increased infection rates, prolonged mechanical ventilation, extended hospital stays, and high mortality [1-3]. However, glycemic control is often considered a lower priority in critical care settings, frequently overshadowed by more immediate life-sustaining interventions [4].

To address this limitation, nurse-led glycemic control protocols have emerged as a pragmatic and effective approach. These protocols enable bedside nurses to initiate and manage insulin therapy, which enhances the timeliness and consistency of glycemic control interventions [2]. Nurse-led glycemic control protocols have been demonstrated to effectively manage hyperglycemia, enhance clinical outcomes, and reduce the incidence of hypoglycemia [2,5].

Recent developments in critical care practice have shown a shift from deep toward minimal sedation while maintaining patients' consciousness level [6]. Furthermore, the increasing adoption of Enhanced Recovery After Surgery protocols—standardized, multidisciplinary approaches that include nutritional management—together with growing evidence for the benefits of early oral feeding, has led to a steady increase in attempts to initiate oral nutrition in critically ill patients [7-9]. Moreover, technologies such as continuous glucose monitoring, decision-support systems (DSSs), and insulin dose calculators have been introduced and implemented to increase management efficiency and reduce cognitive workload among nurses [10-12]. Updating protocols to reflect emerging technologies is crucial to optimize patient care and reduce the cognitive and documentation burdens on nursing staff [13-15]. Within this context, it is necessary to determine whether recently reported nurse-led glycemic control protocols reflect these evolving treatment strategies and clinical environments and whether they contribute to the advancement of evidence-based nursing practice.

A comprehensive examination of current research is crucial to support the refinement of nursing practice based on up-to-date evidence and evolving clinical contexts. Previous studies, including a systematic review, have shown the efficacy of nurse-led insulin infusion protocols; however, they were limited to literature published up to 2021 and predominantly included studies conducted before 2017 [16]. More recently, a scoping review investigated insulin infusion protocols in ICUs, but solely focused on protocol typologies and indicators, excluding broader aspects of glycemic care or non-infusion strategies [5]. These limitations highlight the need for a more comprehensive and current synthesis of the literature encompassing the full spectrum of nurse-led glycemic control practices in critical care settings. Building on these findings, this study conducts a scoping review to comprehensively map nurse-led glycemic control protocols in adult ICUs. This scoping review aims to identify nurse-led glycemic control protocols implemented in ICUs and analyze their components—including target blood glucose ranges, monitoring intervals, and implementation methods—along with associated clinical outcomes.

***KEY MESSAGES***

- Nurse-led protocols enhance glycemic outcomes in critical care settings.
- Expansion of glycemic control protocols to incorporate diverse methods of nutritional intake is warranted.
- Decision-support technologies have promoted the evolution of implementation methods in nurse-led glycemic control.

## MATERIALS AND METHODS

This study did not involve human participants or identifiable personal data and therefore did not require institutional review board approval or informed consent.

### Study Design

We conducted this scoping review in accordance with the JBI Manual for Evidence Synthesis for scoping reviews [17] and reported the findings in adherence to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) checklist [18].

### Eligibility Criteria

We included all peer-reviewed articles on intervention studies published in English and Korean from each database. To accurately reflect recent changes in ICU workflows, we only included studies published from January 1, 2015 to April 3, 2025. The following clinical questions were used as a guide for this study: (1) What are the key components of nurse-led glycemic control protocols in the ICU, as reported in the literature (e.g., target blood glucose range, glucose monitoring frequency, and strategies for hypo- and hyperglycemia management)? (2) What are the reported outcomes of nurse-led glycemic control protocols in the ICU? This scoping review was guided by the PCC (population, concept, and context) [17].

The eligibility criteria were established using the PCC framework: (1) population: adult ICU patients requiring glycemic control; (2) concept: nurse-led glycemic control protocols; and (3) context: adult ICUs. The following exclusion criteria were applied: (1) studies for which the full text was unavailable, (2) non-peer-reviewed articles and gray literature, (3) publications in languages other than English or Korean, (4) studies involving interventions other than nurse-led glycemic control protocols, e) studies conducted in general wards or outpatient settings rather than in ICUs, (5) studies targeting pediatric or adolescent populations, and (6) studies not involving any intervention.

### Search Strategies

This scoping review was conducted using seven databases: PubMed, CINAHL, Embase, Web of Science, Cochrane, RISS, and KISS. To identify suitable studies, MeSH or Embase subject headings were used to identify the relevant keywords: nurses, glycemic control, and ICUs. The complete search strategy is described in Supplementary Material 1.

### Search Selection

All citations and abstracts identified using the search strategy were uploaded to the reference management software (Endnote 21.0) for selection. Studies were independently screened and selected by two reviewers (EH and EP). In the first step of the initial search, the titles and abstracts of the studies were reviewed after removing duplicate articles, and ineligible studies were excluded based on the eligibility criteria. In the second step, the researchers independently reviewed the remaining studies and retrieved the full texts of potentially relevant ones. Any disagreements between the two authors with regard to study inclusion were resolved through discussion.

Two reviewers (EH and EP) independently extracted all the relevant information from the included articles, and EGO cross-verified the results. The data sheet contained the following information from each selected study: author, publication year, country of publication, study design, type of ICU, participants and sample size, study aim, program content, and results. All three researchers evaluated the extracted data for consistency. Discrepancies were resolved through discussion among them. Methodological quality was assessed using the revised JBI critical appraisal tool for quasi-experimental designs [19], independently by two reviewers, with discrepancies resolved through discussion.

## RESULTS

### Search Results

Through systematic database searches, 969 studies were identified. After removing 123 duplicate records, 846 articles remained for title and abstract screening. Of these, 814 were excluded for the following reasons: irrelevance to glucose management or nurse-led interventions, conducted outside of ICUs, and involving non-adult populations. The full texts of the 32 studies were reviewed, which led to the exclusion of 25 studies due to the absence of intervention implementation or the use of ineligible comparison groups. Ultimately, seven studies were included in final analysis. Figure 1 illustrates the comprehensive selection process.

The methodological quality of the seven included studies was evaluated using the revised JBI critical appraisal tool [19]. Quality appraisal indicated that most studies demonstrated validity in terms of temporal precedence, participant selection and allocation, outcome measure validity and reliability, appropriate statistical analyses, and follow-up completeness. However, certain limitations were identified in some studies, particularly regarding the control of confounding variables and the methods used for assigning comparison groups. Despite these limitations, all seven studies were deemed to meet the inclusion criteria and were thus classified as "included" in the final selection. The detailed results of the quality appraisal

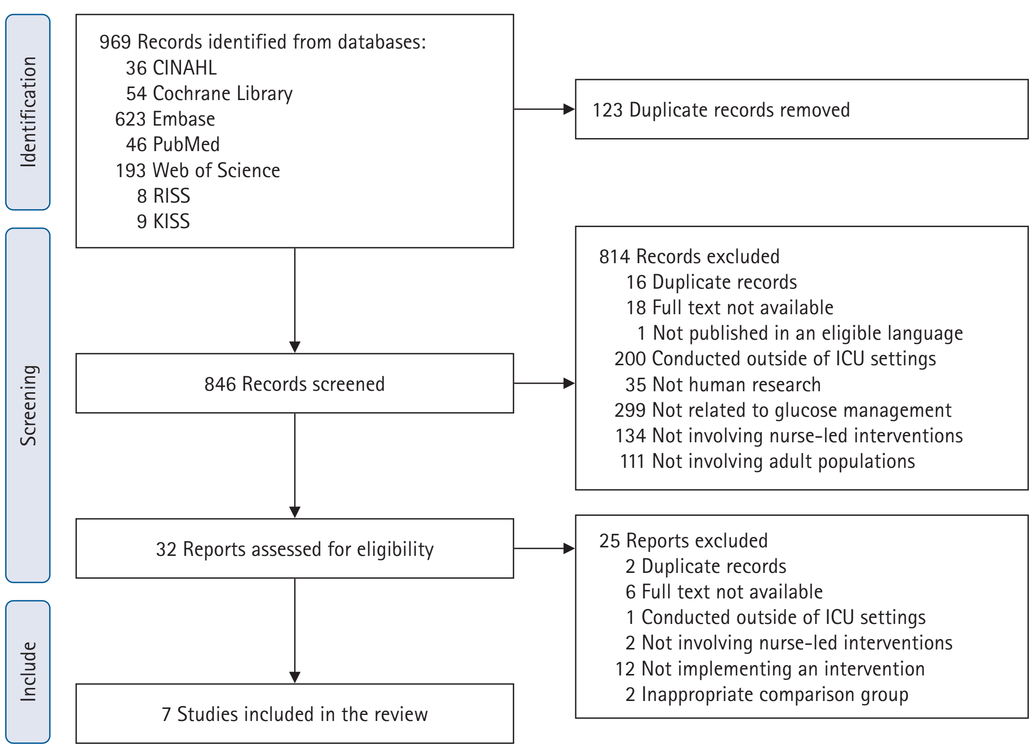



**Figure 1.** Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) flow diagram. ICU: intensive care unit.

are presented in Table 1.

### General Characteristics of the Included Studies

This review included seven studies: two conducted in Korea [20,21], two in the United States [22,23], two in Spain [24,25], and one in Germany [26]. All studies employed quasi-experimental designs and were conducted across various ICUs, including four surgical ICUs [20,21,23,24], one medical ICU [26], and two mixed medical-surgical ICUs [22,25]. With regard to the interventions, five studies implemented continuous intravenous insulin infusion [20,21,24-26] and two focused on hypoglycemia management [22,23]. Table 2 presents a summary of these findings.

### Characteristics of Nurse-Led Glycemic Control Protocols

The target blood glucose range across the included studies was set at 100–180 mg/dl. The frequency of blood glucose monitoring varied depending on the protocol used: in insulin infusion protocols, measurements were performed at intervals ranging from 30 minutes to 4 hours, whereas in hypoglycemia management protocols, monitoring was conducted every 15 minutes. All protocols were applied to patients who were either fasting or receiving continuous enteral nutrition. Patients on oral diets or intermittent enteral feeding were excluded. With regard to the mode of protocol implementation, four studies adopted paper-based protocols, in which nurses manually calculated and adjusted insulin doses according to printed guidelines [20,22,23,26]. The remaining three studies used DSSs that automatically recommended insulin doses and corresponding actions through computerized calculators [21,24,25]. Table 3 presents a summary of these findings.

### Outcomes of Nurse-Led Glycemic Control Protocols

Of the seven studies, the three that evaluated glycemic variability reported significantly lower variability in the nurse led glycemic control protocol group [20-22]. Six studies reported the incidence of hypoglycemia [20,21,23-26], of which four indicated a significantly lower incidence in the nurse led group [20,21,23,26]. Hyperglycemia incidence was assessed in four studies [20,21,25,26], with one reporting a significantly lower incidence in the nurse-led group [20]. The remaining two yielded mixed results across different blood glucose ranges [21,25]. Table 4 presents a summary of these findings.

## DISCUSSION

This scoping review explored recent literature on nurse-led glycemic control management in ICUs. It aimed to identify the outcomes of these interventions and the key characteristics of their protocol components. A total of seven studies met the inclusion criteria. This review highlighted four key findings: (1) nurse-led glycemic control protocols contribute to the enhancement of critical care, (2) guidance for patients on oral nutrition is lacking, (3) efforts to tailor protocols according to specific disease or treatment characteristics is limited, and (4) implementation methods have evolved, particularly with the adoption of decision-support technologies.

The findings of this scoping review suggest that nurse led glycemic control protocols contribute meaningfully to the improvement of glycemic management in critical care settings. Among the included studies, groups applying nurse led protocols yielded more favorable outcomes, particularly with regard to reduced glycemic variability and lower hypoglycemia incidence. These findings suggest that nurse led interventions can support more stringent and safer glucose control, which is a crucial aspect of outcome optimization in critically ill patients. These results partially align with the findings of a previous systematic review, which reported that nurse led protocols appear to control glycemia within predefined ranges and prevent hyper- and hypoglycemia episodes at levels comparable to those of control groups [16]. Taken together, these findings indicate the potential of nurse led glycemic control protocols to advance evidence based nursing practice in critical care. Encouraging nurses to implement standardized protocols may enhance patient outcomes.

None of the included studies considered patients receiving oral nutrition. Most interventions were applied to critically ill patients who were fasting or receiving continuous enteral nutrition, and patients on oral diets or receiving intermittent enteral feeding were either explicitly excluded or not mentioned. This represents a considerable gap, given the clinical relevance of nutritional intake in glycemic control. The Korean Diabetes Association (KDA) stated that oral hypoglycemic agents are generally not recommended during hospitalization due to several factors, such as fasting status, diagnostic proce-

**Table 1.** Results of critical appraisal using the revised JBI critical appraisal tool for quasi-experimental studies (n=7)

| Study | Outcome/result | Internal validity bias related to: | | | | | | | | Statistical conclusion validity |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Temporal precedence | Selection and allocation | Confounding factors | Administration of intervention/exposure | Assessment, detection, and measurement of the outcome | | | Participant retention | |
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| Yoo et al. (2015) [20] | Glucose variability | Y | Y | Y | Y | Y | Y | Y | Y | Y |
| | Hypoglycemia | | | | | Y | Y | Y | Y | Y |
| | Hyperglycemia | | | | | Y | Y | Y | Y | Y |
| Arnold et al. (2015) [22] | Glucose variability | Y | Y | Y | UC | Y | Y | UC | Y | UC |
| | Hypoglycemia | | | | | Y | Y | UC | Y | UC |
| | Hyperglycemia | | | | | NA | NA | NA | NA | NA |
| Compton et al. (2017) [26] | Glucose variability | Y | Y | UC | Y | NA | NA | NA | NA | NA |
| | Hypoglycemia | | | | | Y | Y | Y | Y | UC |
| | Hyperglycemia | | | | | Y | Y | Y | Y | UC |
| Van Berkel et al. (2017) [23] | Glucose variability | Y | Y | UC | UC | NA | NA | NA | NA | NA |
| | Hypoglycemia | | | | | Y | Y | Y | UC | UC |
| | Hyperglycemia | | | | | NA | NA | NA | NA | NA |
| Rodriguez-Calero et al. (2019) [25] | Glucose variability | Y | Y | Y | Y | NA | NA | NA | NA | NA |
| | Hypoglycemia | | | | | Y | Y | Y | UC | Y |
| | Hyperglycemia | | | | | Y | Y | Y | UC | Y |
| Yoo et al. (2021) [21] | Glucose variability | Y | Y | Y | Y | Y | Y | Y | Y | Y |
| | Hypoglycemia | | | | | Y | Y | Y | Y | Y |
| | Hyperglycemia | | | | | Y | Y | Y | Y | Y |
| González-Caro et al. (2022) [24] | Glucose variability | Y | Y | Y | Y | NA | NA | NA | NA | NA |
| | Hypoglycemia | | | | | Y | Y | Y | Y | Y |
| | Hyperglycemia | | | | | NA | NA | NA | NA | NA |

Y: yes; UC: unclear; NA: not applicable.

**Table 2.** Summary of the study characteristics of nurse-led glycemic control protocols in ICUs (n=7)

| Study | Country | Type of ICU | Protocol type |
|---|---|---|---|
| Yoo et al. (2015) [20] | Korea | CSICU | Continuous intravenous insulin infusion protocol |
| Arnold et al. (2015) [22] | United States | ICU | Hypoglycemia management protocol |
| Compton et al. (2017) [26] | Germany | MICU | Continuous intravenous insulin infusion protocol |
| Van Berkel et al. (2017) [23] | United States | NCCU,SICU | Hypoglycemia management protocol |
| Rodriguez-Calero et al. (2019) [25] | Spain | MICU, SICU | Continuous intravenous insulin infusion protocol |
| Yoo et al. (2021) [21] | Korea | CSICU | Continuous intravenous insulin infusion protocol |
| González-Caro et al. (2022) [24] | Spain | CSICU | Continuous intravenous insulin infusion protocol |

ICU: intensive care unit; CSICU: cardiothoracic surgical intensive care unit; MICU: medical intensive care unit; NCCU: neurosciences critical care unit; SICU: surgical intensive care unit.

**Table 3.** Components of nurse-led glycemic control protocols in ICUs (n=7)

| Study | Glucose target (mg/dl) | Glucose monitoring frequency | Application to oral nutrition patients | Implementation method |
|---|---|---|---|---|
| Yoo et al. (2015) [20] | 110–150 | 2hr (30min in case of hypoglycemia) | Not applicable | Paper-based |
| Arnold et al. (2015) [22] | 120–150 (80–110: cardiac surgery patients) | 15 min | Not reported | Paper-based |
| Compton et al. (2017) [26] | 140–180 | 1–4 hr | Not reported | Paper-based |
| Van Berkel et al. (2017) [23] | 110–150 | 15 min | Not reported | Paper-based |
| Rodriguez-Calero et al. (2019) [25] | 140–180 | 1 hr | Not applicable | Computer-based calculator |
| Yoo et al. (2021) [21] | 100–180 | 2–4 hr | Not applicable | Computer-based calculator |
| González-Caro et al. (2022) [24] | 100–160 | 30 min–4 hr | Not reported | Automated infusion pump |

ICU: intensive care unit.

**Table 4.** Summary of the study outcomes of nurse-led glycemic control protocols in ICUs (n=7)

| Study | Glucose variability | Incidence of hypoglycemia | Incidence of hyperglycemia |
|---|---|---|---|
| Yoo et al. (2015) [20] | IG<CG[a)] | IG<CG[a)] | IG<CG[a)] |
| Arnold et al. (2015) [22] | IG<CG[a)] | NA | NA |
| Compton et al. (2017) [26] | NA | IG<CG[a)] | Not significant |
| Van Berkel et al. (2017) [23] | NA | IG>CG[a),b)] | NA |
| Rodriguez-Calero et al. (2019) [25] | NA | Not significant | 181–200: IG>CG[a)], >200: IG<CG[a)] |
| Yoo et al. (2021) [21] | IG<CG[a)] | IG<CG[a)] | 181–200: IG>CG[a)], 201–300: not significant, >300: IG<CG[a)] |
| González-Caro et al. (2022) [24] | NA | Not significant | NA |

ICU: intensive care unit; IG: intervention group; CG: comparison group; NA: not applicable.
a) Statistically significant at a level of 0.05; b) Treated hypoglycemia reported instead of overall incidence.

dures involving contrast agents, and potential adverse effects [27]. In contrast, the American Diabetes Association (ADA) recommend transition protocols, whereby intravenous insulin doses are converted to basal insulin combined with pre-meal rapid-acting insulin subcutaneously administered [28].

Across the studies, target blood glucose range was set between 100 and 180 mg/dl. This aligns with previous studies [5,16]. Notably, our finding that disease specific tailoring was largely absent suggests that current recommendations to incorporate differentiation by disease categories or patient specific metabolic requirements [29] have not yet been fully reflected in clinical practice. However, some studies have attempted to adjust target ranges based on patient-specific factors including disease characteristics and surgical status. The protocols applied in surgical ICUs tended to set lower upper limits (e.g., 150–160 mg/dl), potentially to mitigate the risk of postoperative infection associated with hyperglycemia. In contrast, studies that allowed an upper target of 180 mg/dl [21,25] reported higher frequencies of mild hyperglycemia (180–200 mg/dl) in the intervention groups compared with controls. The ADA and KDA recommend individualized target glucose levels, suggesting a range of 140–180 mg/dl for most critically ill patients [27,28]. Stricter control, within the range of 110–140 mg/dl, is cautiously advised in selected cases requiring stringent glycemic management, such as in postoperative care [27,30].

A notable trend in recent studies is the integration of technology-based tools, including glucose calculators and DSSs. The most recently published studies included in this review used computerized DSSs to facilitate nurse-led glycemic control [21,24,25]. Moreover, current clinical guidelines recommend glycemic management through paper-based and computerized protocols [27,28]. DSSs have been shown to enhance nurses' clinical decision-making, improve safety and accuracy in clinical practice, promote standardization of care, and contribute to better patient outcomes [13-15].

Our results indicate that nurses play a pivotal role as implementers of glycemic control in ICUs; however, there remains a need to broaden protocol design to reflect nutritional diversity and disease specific tailoring. When situated within the broader literature, our findings align with those of previous reviews that examined nurse led protocols for glycemic management in critical care [5,16]. This highlights the importance of further empowering nurses as leaders in the development and implementation of such protocols.

This scoping review had some limitations. First, only studies published in English or Korean were included, which may have introduced language bias and led to the exclusion of relevant research published in other languages. Second, the review focused solely on quasi-experimental designs, which, although informative, may limit the generalizability of the findings due to potential biases inherent in nonrandomized study designs.

## CONCLUSIONS

The findings of this study highlight the need to review and update current glycemic management protocols across healthcare settings. The implementation of an evidence-based approach through multidisciplinary collaboration is crucial. We recommend developing standardized protocols that incorporate the nutritional diversity of patients in the ICU, including specific guidance for those on oral diets. In addition, the integration of practical tools such as insulin dosage calculators and electronic medical record–linked protocols into clinical practice is needed to enhance glycemic control in critical care.


## CONFLICT OF INTEREST

No potential conflict of interest relevant to this article was reported.

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Conceptualization: EH, EP. Methodology: EH, EP, EGO. Data curation: EH, EP. Visualization: EH. Project administration: EH, EP, EGO. Funding acquisition: EH, EP. Writing – original draft: EH, EP. Writing – review & editing: EH, EP, EGO. All authors read and agreed to the published version of the manuscript.

## SUPPLEMENTARY MATERIALS

Supplementary materials can be found via https://doi.org/10.4266/acc.003225.

## REFERENCES


1. Mifsud S, Schembri EL, Gruppetta M. Stress-induced hypergly-

caemia. Br J Hosp Med (Lond) 2018;79:634-9.
2. Robinson A, Mathiason MA, Manchester C, Tracy MF. Evaluation of nurse-driven management of hypoglycemia in critically ill patients. Am J Crit Care 2024;33:218-25.
3. Lacherade JC, Jacqueminet S, Preiser JC. An overview of hypoglycemia in the critically ill. J Diabetes Sci Technol 2009;3:1242-9.
4. Cohen S, Clark RR. Improving the timing of acute care insulin delivery. Am J Nurs 2024;124:48-54.
5. Huang M, Yang R, Pang D, Gan X. Insulin infusion protocols for blood glucose management in critically ill patients: a scoping review. Crit Care Nurse 2024;44:21-32.
6. Pearson SD, Patel BK. Evolving targets for sedation during mechanical ventilation. Curr Opin Crit Care 2020;26:47-52.
7. Nieminen T, Tapiovaara L, Bäck L, Lindford A, Lassus P, Lehtonen L, et al. Enhanced recovery after surgery (ERAS) protocol improves patient outcomes in free flap surgery for head and neck cancer. Eur Arch Otorhinolaryngol 2024;281:907-14.
8. Othenin-Girard A, Ltaief Z, Verdugo-Marchese M, Lavanchy L, Vuadens P, Nowacka A, et al. Enhanced recovery after surgery (ERAS) protocols in cardiac surgery: impact on opioid consumption. J Clin Med 2025;14:1768.
9. Reta-Pérez O, Colmenero-Ruiz M, Hernández-Socorro CR, Saavedra P, Maichle SF, Portugal E, et al. Trophic nutrition in ICU patients undergoing high-flow oxygen therapy and/or noninvasive mechanical ventilation: the Nutri-Trophic study. Nutrients 2024;16:1366.
10. Campion TR, Waitman LR, Lorenzi NM, May AK, Gadd CS. Barriers and facilitators to the use of computer-based intensive insulin therapy. Int J Med Inform 2011;80:863-71.
11. Guerrero-Arroyo L, Faulds E, Perez-Guzman MC, Davis GM, Dungan K, Pasquel FJ, et al. Continuous glucose monitoring in the intensive care unit. J Diabetes Sci Technol 2023;17:667-78.
12. Karippacheril JG, Mathai RT, Abraham SS. Insulin IP Calc: a smartphone application for insulin infusion protocol in intensive care units. Indian J Anaesth 2015;59:829-30.
13. Agnihotri T, Fan M, McLeod S, Borgundvaag B, Ovens H, McCarron J, et al. Impact of an electronic decision-support system on nursing triage process: a usability and workflow analysis. Can J Nurs Res 2021;53:107-13.
14. Almagharbeh WT. The impact of AI-based decision support systems on nursing workflows in critical care units. Int Nurs Rev 2025;72:e13011.
15. Kulasa K, Serences B, Nies M, El-Kareh R, Kurashige K, Box K, et al. Insulin infusion computer calculator programmed directly into electronic health record medication administration record. J Diabetes Sci Technol 2021;15:214-21.
16. Rovida S, Bruni A, Pelaia C, Bosco V, Saraco G, Galluzzo E, et al. Nurse led protocols for control of glycaemia in critically ill patients: a systematic review. Intensive Crit Care Nurs 2022;71:103247.
17. Peters MDJ, Marnie C, Tricco AC, Pollock D, Munn Z, Alexander L, et al. Updated methodological guidance for the conduct of scoping reviews. JBI Evid Implement 2021;19:3-10.
18. Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. BMJ 2021;372:n71.
19. Barker TH, Habibi N, Aromataris E, Stone JC, Leonardi-Bee J, Sears K, et al. The revised JBI critical appraisal tool for the assessment of risk of bias for quasi-experimental studies. JBI Evid Synth 2024;22:378-88.
20. Yoo HJ, Lee NJ, Lee SH. The effects of the application of a glucose control protocol on glycemia and glucose variability in critically ill cardiothoracic surgery patients. J Crit Care Nurs 2015;8:1-12.
21. Yoo HJ, Suh EE, Shim J. Effectiveness of blood glucose control protocol for open heart surgery patients. J Adv Nurs 2021;77:275-85.
22. Arnold P, Paxton RA, McNorton K, Szpunar S, Edwin SB. The effect of a hypoglycemia treatment protocol on glycemic variability in critically ill patients. J Intensive Care Med 2015;30:156-60.
23. Van Berkel MA, MacDermott J, Dungan KM, Cook CH, Murphy CV. Tiered protocol implementation improves treatment of hypoglycaemia in a neurosciences critical care and surgical intensive care unit. Intensive Crit Care Nurs 2017;43:6-11.
24. González-Caro MD, Fernández-Castillo RJ, Carmona-Pastor M, Arroyo-Muñoz FJ, González-Fernández FJ, Garnacho-Montero J, et al. Effectiveness and safety of the Space GlucoseControl system for glycaemia control in caring for postoperative cardiac surgical patients. Aust Crit Care 2022;35:136-42.
25. Rodriguez-Calero MA, Barceló Llodrá E, Cruces Cuberos M, Blanco-Mavillard I, Pérez Axartell MA. Effectiveness of an evidence-based protocol for the control of stress-induced hyperglycaemia in critical care. Enferm Intensiva (Engl Ed) 2019;30:4-12.

26. Compton F, Ahlborn R, Weidehoff T. Nurse-directed blood glucose management in a medical intensive care unit. Crit Care Nurse 2017;37:30-40.
27. Korean Diabetes Association. 2023 Clinical practice guidelines for diabetes. 8th ed. Seoul Medcus; 2023.
28. American Diabetes Association Professional Practice Committee. 16. Diabetes care in the hospital: standards of care in diabetes-2024. Diabetes Care 2024;47:S295-306.
29. Wu Z, Liu J, Zhang D, Kang K, Zuo X, Xu Q, et al. Expert consensus on the glycemic management of critically ill patients. J Intensive Med 2022;2:131-45.
30. Bojar RM. Manual of perioperative care in adult cardiac surgery. John Wiley Sons; 2020.