Int J Clin Exp Med 2026;19(4):116-133
www.ijcem.com /ISSN:1940-5901/IJCEM0170191

Original Article

Summary and application of the best evidence for prevention and management of refeeding syndrome in ICU patients

Nan Feng[1], Wen-Jie Xiao[1], Li-Ping He[2], Jia-Hong Liu[1], Li-Ju Xie[1], Jing Zhang[1], Hai-Gang Zhang[1], Yu-Ju Qin[1]

[1]Department of Critical Care Medicine, Shenzhen Nanshan District People's Hospital, Shenzhen, Guangdong, China; [2]Department of Urology, Huadu District People's Hospital of Guangzhou, Guangzhou, Guangdong, China

Received November 22, 2025; Accepted March 19, 2026; Epub April 15, 2026; Published April 30, 2026

Abstract: Aim: To implement best evidence-based practices for preventing and managing refeeding syndrome (RFS) in ICU patients using the JBI Evidence Implementation Framework, with the goal of reducing RFS incidence and improving patient outcomes. Methods: Literature related to RFS prevention and management was systematically retrieved. Following quality appraisal, best evidence was synthesized. Evidence-based audit criteria were developed by integrating the summarized evidence with clinical context and expert judgment. A quality improvement project was conducted in the ICU, involving baseline and post-implementation audits to evaluate the effectiveness of the evidence implementation. Results: Eighteen articles were included, from which 24 best practice recommendations were summarized. Eighteen evidence-based audit criteria were developed. Following implementation, a statistically significant reduction was observed in the incidence of RFS ($P<0.05$). The incidence of complications associated with RFS, including electrolyte imbalances and cardiac dysfunction, also significantly decreased ($P<0.05$). Conclusion: Implementing best evidence-based practices for RFS prevention and management, guided by the JBI Evidence Implementation Framework, effectively reduces the incidence of RFS, improves patient outcomes, and enhances nursing quality in the ICU setting.

Keywords: JBI evidence implementation framework, intensive care unit (ICU), refeeding syndrome (RFS), prevention, management, evidence-based practice

Introduction

Refeeding syndrome (RFS) is a common yet easily overlooked complication among ICU patients, particularly prevalent in those with long-term malnutrition [1]. RFS is closely associated with metabolic disturbances following the resumption of nutritional support, manifesting primarily as electrolyte imbalances (e.g., hypophosphatemia, hypokalemia, hypomagnesemia), fluid equilibrium disorders, cardiac dysfunction, and in severe cases, death [2, 3]. To date, a consensus on the definition of refeeding syndrome (RFS) has not been reached domestically and internationally. Referring to the definitions and diagnostic criteria for RFS proposed by domestic scholars and the 2020 ASPEN consensus, RFS in this study was defined as the occurrence of the following manifestations within 3 days after the initiation of enteral nutrition support: serum phosphorus <0.85 mmol/L with a decrease of ≥30% or ≥0.16 mmol/L from the baseline level, accompanied by hypokalemia (serum potassium <3.50 mmol/L) and hypomagnesemia (serum magnesium <0.75 mmol/L). On this basis, the presence of any clinical symptom involving multiple systems was also required, including tachycardia, respiratory failure, cardiac arrhythmia, nausea and vomiting, edema, delirium, coma, and other related manifestations.

ICU patients are at high risk of RFS due to critical illness, metabolic disorders, and inadequate nutritional intake, with an incidence rate ranging from 17% to 52%. Once RFS occurs, it can lead to multi-organ damage, increased infection rates, and elevated mortality, resulting in poor clinical outcomes [4, 5]. Therefore, early screening for high-risk factors and prompt

https://doi.org/10.62347/CSXS5428

implementation of targeted interventions are crucial for improving patient prognosis.

The JBI Evidence Translation Model is a systematic framework designed to translate best evidence into clinical practice. This study, based on the JBI model, explores the optimal evidence-based practices for preventing and managing RFS in ICU patients, aiming to provide scientific rationale for clinical nursing. Our objectives include systematically retrieving, appraising, and synthesizing evidence related to early interventions and management of RFS in ICU patients undergoing refeeding (via oral intake, enteral, or parenteral nutrition). By identifying high-risk populations early and implementing preventive measures, we seek to improve patient outcomes. Through this JBI-based RFS prevention and management project, we aim to reduce RFS-related complications and mortality while enhancing the quality of critical care nursing.

Materials and methods

Evidence summary

Literature search

A search was conducted in accordance with the "6S" evidence model in UpToDate, JBI Evidence-Based Healthcare Database, BMJ Best Practice, Embase, National Institute for Health and Care Excellence (NICE) Guidelines, Registered Nurses' Association of Ontario (RNAO), Australian Guidelines Library, American Society for Parenteral and Enteral Nutrition (ASPEN), European Society for Clinical Nutrition and Metabolism (ESPEN), British Association for Parenteral and Enteral Nutrition, Cochrane Library, PubMed, China National Knowledge Infrastructure (CNKI), WanFang Data, and Chinese Biomedical Literature Service System. The search period was from January 2015 to June 2025 [6].

The search strategy was created using a combination of subject and free words. The terms for the search were (Refeeding Syndrome/Refeeding Disorder/Enteral Nutrition/Malnutrition/Hypophosphatemia) AND (ICU/Intensive Care Unit/Critically Ill Patients) AND (Evidence-Based Practice/Knowledge Translation/Guidelines/Clinical Decision-Making/Evidence Summaries/Expert Consensus/Systematic Reviews/meta-Analyses/Randomized Controlled Trials).

Basic characteristics and quality appraisal of included studies

Basic characteristics of included studies: An evidence-based question was developed using the PIPOST framework [7]. P: Critically ill patients in the intensive care unit (ICU) with refeeding syndrome (RFS), I: Assessment, nursing care and intervention for RFS, P: Clinical healthcare providers, O: Incidence of RFS, the level of awareness of RFS among healthcare providers and patients, patient compliance with RFS preventive measures, etc., S: Intensive care unit (ICU), T: Best practices, evidence summaries, clinical guidelines, systematic reviews and literature reviews, expert consensuses, and original studies closely related to this topic. The inclusion criteria for this study were as follows: ① Adult patients in the intensive care unit (ICU) diagnosed with refeeding syndrome (or refeeding disorder) or requiring high-risk nutritional support. ② Nutritional therapy for ICU patients, including assessment, therapeutic care, and pharmacotherapy. ③ Healthcare professionals (physicians and nurses) as the implementers of evidence-based practices. ④ Outcomes including incidence of refeeding syndrome, electrolyte disorders (hypophosphatemia, hypokalemia), prolonged mechanical ventilation, in-hospital mortality, and nutritional adequacy rate. ⑤ Hospital setting for evidence application. ⑥ Evidence types including clinical decisions, guidelines, expert consensus, evidence summaries, systematic reviews, meta-analyses, and randomized controlled trials. ⑦ Literature in Chinese or English. Exclusion criteria: ① Duplicate publications, incomplete information, or inaccessible full texts. ② Literature types such as abstracts, drafts, or reports. ③ Studies failing to meet quality appraisal requirements. A total of 18 studies were included, comprising 5 guidelines, 2 clinical decisions, 3 systematic reviews, 4 expert consensus documents, and 4 retrospective case-control studies. The literature screening process is shown in **Figure 1**, and the general characteristics of the included studies are presented in **Table 1**.

Quality appraisal of literature: The Appraisal of Guidelines for Research and Evaluation (AGREEII) 2012 edition was used to evaluate the quality of guidelines [26]. For systematic

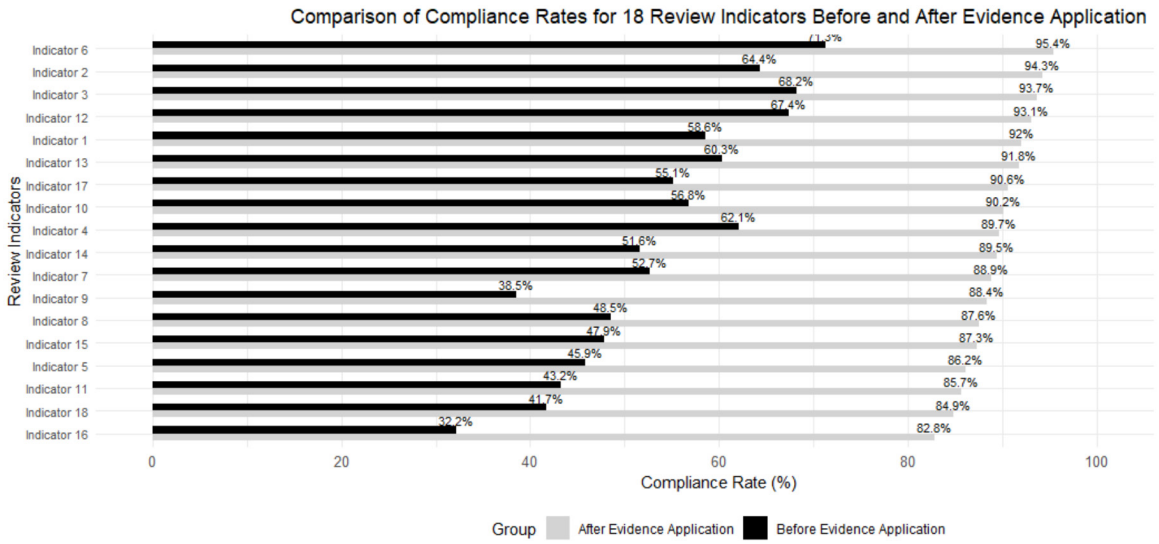

Figure 1. Compliance rates of the 18 audit criteria.

reviews, randomized controlled trials (RCTs), cohort studies, case-control studies, and expert consensus, the corresponding evaluation criteria published by the Joanna Briggs Institute (JBI) for Evidence-Based Healthcare (2016) were applied [7]. Evidence from UpToDate was defaulted as high-level evidence. For evidence summaries, quality appraisal traced back to the original sources and adopted JBI evaluation criteria. Two researchers specialized in critical care nutrition nursing and trained in evidence-based practice independently conducted the appraisal. In case of disagreements, a third researcher was involved for discussion until consensus was reached.

Results of literature quality appraisal: (1) The quality appraisal results of the 5 guidelines included in this study are shown in **Table 2**. All guidelines demonstrated good overall quality and were approved for inclusion. (2) Quality appraisal of 2 clinical decisions. A total of 2 clinical decisions from UpToDate were included. One study had Item 9 evaluated as "unclear", with all other items rated "yes"; the other study had Items 1-5 rated "yes", Items 7-8 rated "no", and showed high overall quality, and were thus included. (3) Quality appraisal results of 3 systematic reviews. Among the 3 included systematic reviews: Friedli et al.'s study had Item 9 ("Assessed the possibility of publication bias") evaluated as "unclear". Chen L et al.'s study had Items 6-8 rated "no", with other items "yes". Matthews-Rensch et al.'s study had Item 8 ("Clearly described how to integrate study results") evaluated as "unclear", with other items "yes". All 3 systematic reviews showed high overall quality and were included, as shown in **Table 4**. (4) Quality appraisal of 4 expert consensus documents. The expert consensus from the Chinese Emergency/Critical Care Expert Group (2024) and da Silva et al. (2020) had all items rated "yes". For the consensus from the Nutrition Professional Committee of Chinese Anti-Cancer Association and Chen Wei et al., Item 6 was "unclear", but other items were "yes", indicating high overall quality, as shown in **Table 3**. (5) Quality appraisal of 4 retrospective case-control studies. Material was evaluated using the Newcastle-Ottawa Quality Scale (NOS), all items were rated "yes", and the studies were approved for inclusion.

Two researchers independently extracted the evidence, and other members jointly translated and proofread the material. The principles to be followed in evidence summarization are as follows: when the extracted evidence is consistent, the evidence with professional expression and easy comprehensibility should be prioritized; when the evidence contents complement each other, they should be merged according to the logical relationship between them; when there are conflicts in evidence conclusions, the conclusions of high-quality and newly published evidence should be given priority [27, 28]. The JBI Evidence Pre-grading System (2014 edition) was adopted for evidence grading. This system classifies evidence from high to low levels into

Table 1. Basic characteristics of included studies (n=18)

Included Literature	Evidence Source	Evidence Type	Evidence Theme	Publication Year
Singer et al. (Singer et al., 2023) [8]	ESPEN Official Website	Guideline	Principles of nutritional support for critically ill patients, including RFS prevention and management	2023
Boland et al. [9]	Irish Society for Parenteral and Enteral Nutrition (IRSPEN)	Guideline	Prevention and treatment of RFS in patients	2021
NICE [10]	National Institute for Health and Care Excellence (NICE), UK	Guideline	RFS screening and enteral nutrition implementation process	2017
Geriatrics Society of Chinese Medical Association [11]	China National Knowledge Infrastructure (CNKI)	Guideline	Management recommendations for RFS in elderly critically ill patients	2023
NHS [12]	National Health Service (NHS), UK	Guideline	Guidelines for prevention and management of adult RFS	2018
David Seres et al. [13]	UpToDate	Clinical Decision	Nutritional support for adult critically ill patients: initial assessment and prescription	2025
David Seres et al. [14]	UpToDate	Clinical Decision	Enteral nutrition for adult critically ill patients	2024
Friedli et al. [15]	PubMed	Systematic Review	Risk factors and prevention or treatment of RFS	2017
Cioffi et al. [16]	PubMed	Systematic Review	Incidence of RFS	2021
Matthews-Rensch et al. [17]	PubMed	Systematic Review	Systematic review of initial energy intake and RFS	2021
da Silva et al. [18]	PubMed	Expert Consensus	ASPEN expert consensus on refeeding syndrome	2020
Chinese Emergency/Critical Care Expert Group [19]	CNKI	Expert Consensus	Expert consensus on clinical practice of parenteral nutrition therapy	2024
Nutrition Professional Committee of Chinese Anti-Cancer Association [20]	CNKI	Expert Consensus	Expert consensus on refeeding syndrome in cancer patients	2023
Chen Wei et al. [21]	CNKI	Expert Consensus	Chinese expert consensus on the application of electrolytes in parenteral nutrition	2024
Ruiqi Xiong et al. [22]	PubMed	Retrospective Case-Control Study	Incidence and outcomes of refeeding syndrome in neurocritical care patients	2020
Wei Zhang et al. [23]	PubMed	Retrospective Case-Control Study	Risk factors for refeeding syndrome in neurocritical care patients	2023
Wong et al. [24]	PubMed	Retrospective Case-Control Study	Prevalence, risk factors, and prediction of refeeding hypophosphatemia in patients receiving parenteral nutrition	2020
Ralib et al. [25]	PubMed	Retrospective Case-Control Study	Risk factors and outcomes of refeeding hypophosphatemia in Malaysian ICU patients receiving enteral nutrition	2018

Table 2. Methodological quality evaluation results of the clinical guidelines (n=5)

Guideline	Standardized scores in various domains (%)						≥60% field number (n)	≥30% field number (n)	Recommendation level
	Scope and purpose	Stakeholder involvement	Rigor of development	Clarity of presentation	Applicability	Editorial independence			
ESPEN [8]	83.33%	84.72%	87.50%	94.44%	56.25%	95.85%	5	6	B
IRSPEN [9]	88.56%	70.83%	82.29%	83.33%	70.83%	95.83%	6	6	A
NICE [10]	97.22%	69.44%	94.79%	97.22%	75.00%	70.83%	6	6	A
Geriatrics Society of Chinese Medical Association [11]	73.61%	69.44%	48.44%	86.11%	64.54%	54.17%	4	6	B
NHS [12]	77.78%	70.83%	63.02%	91.57%	62.595	79.17%	6	6	A

Table 3. Quality evaluation results of expert consensus (n=4)

Items	da Silva et al. [18]	Chinese Emergency/Critical Care Expert Group [19]	Nutrition Professional Committee of Chinese Anti-Cancer Association [20]	Chen Wei et al. [21]
1. Is the source of the comment cleared?	Yes	Yes	Yes	Yes
2. Is the source of comment from the expertise field?	Yes	Yes	Yes	Yes
3. Does comment involve conflict of interest?	Yes	Yes	Yes	Yes
4. Has the comment been verified, and is there logic in the stated expression?	Yes	Yes	Yes	Yes
5. Are there reference sources?	Yes	Yes	Yes	Yes
6. Is there logical defense for the incongruence with extant literature?	Yes	Yes	Unclear	Unclear

Table 4. Quality evaluation results of systematic review (n=3)

Items Marik PE et al.	Friedli et al.	Cioffi et al.	Matthews-Rensch et al.
1. Identifiable study questions	Yes	Yes	Yes
2. Logical inclusion and exclusion criteria	Yes	Yes	Yes
3. Appropriate retrieval strategy	Yes	Yes	Yes
4. Comprehensive databases	Yes	Yes	Yes
5. Appropriate quality evaluation method	Yes	Yes	Yes
6. Independent quality assessment completed by two or more researchers	Yes	Yes	Yes
7. Reasonable production of point	Yes	No	Yes
8. Appropriate methodology for different types of studies	Yes	No	Unclear
9. Report of bias evaluation	Unclear	Yes	Yes
10. Option based on results	Yes	Yes	Yes
11. Appropriate directions for future research	Yes	Yes	Yes

Level 1 to 5 according to different evidence types. The best evidence for the prevention and management of RFS in ICU patients is summarized in **Table 5**.

Optimal evidence application for RFS prevention and management in ICU patients

This project adopted the evidence application model of Fudan University JBI Evidence-based Nursing Center. A clinical study was conducted from January to December 2024 in the ICU of a tertiary grade A hospital, involving three stages: baseline review before evidence application, practice transformation, and effectiveness evaluation after evidence application.

Baseline review

Establishment of review team: The quality review team consisted of 9 members: 1 nutrition specialist nurse as team leader, responsible for overall project planning, team training, and ensuring the safety of evidence translation and objectivity-consistency of quality review; 2 ward head nurses in charge of process decision-making and departmental coordination; 1 director of nursing department ensuring project resources; 2 chief physicians responsible for medical support; 1 dietitian providing nutrition knowledge training for nurses and verifying medical orders; 2 graduate students in charge of data collection and analysis; 1 evidence-based nursing tutor for full-process tracking, guidance, and review of the project.

Establishment of review indicators and methods: Expert letter consultation was conducted. In addition to the 9 project team members, 2 in-hospital nutrition specialist nurses were invited to analyze and evaluate the integrated best evidence based on the FAME principles (Feasibility, Appropriateness, Meaningfulness, Effectiveness). Combining the clinical context of evidence translation and institutional resources, 18 quality review indicators were constructed. The review objects and data collection methods for each indicator were determined item by item (see **Table 5**). A Cognitive Questionnaire on RFS Prevention and Management for Nurses was self-developed based on best evidence and expert opinions. Each correct answer was scored 5 points (total 100 points); higher scores indicated better cognitive level. The ICU Patient Monitoring Form was designed to track the status of each ICU patient, with complication criteria referenced from the 2016 INS (Infusion Nurses Society) guidelines. The RFS Prevention and Management Review Form was developed to conduct on-site review of RFS prevention and management implementation by nursing staff (**Table 6**).

Barrier factors analysis

Based on the integration of baseline review results and team discussions, the review team identified five barrier factors: ① Lack of awareness of multidisciplinary collaborative management for nutritional risks, with insufficient communication among nurses, physicians, and dietitians; ② Deficiency in stepwise nutritional management concepts, including unfamiliarity with calorie/protein increment pathways and risk control requirements; ③ Nurses' inade-

Table 5. Summary of the best evidence for prevention and management of refeeding syndrome in ICU patients

Category	Content of evidence	Evidence level	Recommendation level
Early Screening and Assessment	Screening tools 1. All inpatients should be screened upon admission, and repeated weekly. The screening should combine the Nutritional Risk Screening 2002 (NRS 2002) with biochemical indicators (serum phosphorus, magnesium, and potassium) [8, 9, 12].	Level 1	A
	High-risk Populations 2. ① Prolonged fasting (>7 days); ② Body mass index (BMI) <16 kg/m^2; ③ Recent weight loss >15%; ④ Low albumin (<30 g/L) or prealbumin (<150 g/L) as core risk factors; ⑤ Comorbid diabetes mellitus; ⑥ Chronic alcohol dependence; ⑦ Mechanical ventilation duration >48 hours; ⑧ APACHEII score >16, etc., which significantly increase the risk; ⑨ Elderly patients; ⑩ Patients receiving continuous venovenous hemofiltration and peritoneal dialysis; ⑪ High malnutrition risk score (i.e., NRS2002 ≥3 points); ⑫ Malabsorptive conditions (e.g., short bowel syndrome, Crohn's disease, cystic fibrosis, pyloric stenosis, dyspepsia, pancreatic insufficiency), oncological patients, and post-bariatric surgery patients; ⑬ Patients with excessive or rapid caloric intake [8, 9, 22-25].	Level 2	A
	Risk Factors 3. Risk factors include: (1) Low-risk factors: ① BMI <18.5 kg/m^2; ② Unintentional weight loss >10% within the past 3-6 months; ③ Minimal or no energy supply >5 days; ④ History of alcohol abuse or medication use (insulin, chemotherapeutic agents, acid suppressants, or diuretics). (2) High-risk factors: ① BMI <16.0 kg/m^2; ② Unintentional weight loss >15% within the past 3-6 months; ③ Minimal or no energy supply >10 days; ④ Low baseline electrolyte levels (phosphorus, magnesium, potassium) before nutritional support. (3) Extremely high-risk factors: ① BMI <14 kg/m^2; ② Weight loss >20%; ③ Starvation or fasting >15 days [13, 14].		
	Risk Grading 4. Risk grades: ① Low-risk patients: With 1 low-risk factor; ② High-risk patients: With 2 low-risk factors or 1 high-risk factor; ③ Extremely high-risk patients: With 1 extremely high-risk factor [15, 16].		
Principles of Nutritional Support	Priority of Enteral Nutrition (EN) 5. All ICU patients without contraindications should initiate EN within 24-48 hours [8, 18].	Level 3	A
	Caloric Provision 6. Initial calorie intake should be 10-20 kcal/kg/d, gradually increasing to target calories [8, 18].	Level 3	A
	Nutritional Route 7. Enteral nutrition (EN) is preferred over parenteral nutrition (PN) (reduces infection risk and intestinal function impairment) [8, 10, 13].	Level 1	A
Timing of EN Initiation	General Patients 8. Initiate enteral nutrition (EN) within 24-72 hours after hemodynamic stabilization [17, 18].	Level 3	A
	High-risk Patients 9. For patients with severe metabolic disorders (e.g., hypophosphatemia), correct electrolytes to safe levels before initiating EN [8, 19].	Level 1	B
Nutritional Intake	Total Caloric Intake 10. Nutritional therapy should start with low-calorie targets and gradually increase energy supplementation in an individualized manner. (1) Low-risk population: ① Days 1-3: 15-25 kcal/(kg·d); ② Day 4: 30 kcal/(kg·d); ③ Days 5-10: Full target calories; (2) High-risk population: ① Days 1-3: 10-15 kcal/(kg·d); ② Days 4-5: 15-25 kcal/(kg·d); ③ Day 6: 25-30 kcal/(kg·d); ④ Days 7-10: Full target calories; (3) Extremely high-risk population: ① Days 1-3: 5-10 kcal/(kg·d); ② Days 4-6: 10-20 kcal/(kg·d); ③ Days 7-9: 20-30 kcal/(kg·d); ④ Day 10: Full target calories [10, 11].	Level 1	B
	Protein Intake 11. Initiate at a lower dose <0.8 g/(kg·d), and gradually increase the protein dosage to the target amount ≥1.2-1.3 g/(kg·d) [10, 12].	Level 3	B
	Thiamine 12. (1) Low-risk and high-risk populations: Days 1-3: Supplement with thiamine (vitamin B1) 200-300 mg. (2) Extremely high-risk populations: Days 1-5: Supplement with thiamine (vitamin B1) 200-300 mg. (3) Notes: Administer thiamine at least 30 minutes before initiating nutritional therapy [9, 21].	Level 3	A

	Electrolyte: Phosphorus 13. (1) Mild deficiency (0.6-0.8 mmol/L): Supplement with 1 g phosphate daily via oral or enteral nutrition therapy. (2) Moderate deficiency (0.3-0.6 mmol/L): ① Supplement with 1 g phosphate daily via oral or enteral nutrition. ② Or administer via peripheral vein: 0.08 mmol/kg phosphate over 6 hours. Recheck serum phosphate concentration 6-12 hours after infusion, with repeated checks as needed. Maximum intake of 50 mmol/L phosphate within 24 hours. ③ Check serum phosphate levels daily. Discontinue infusion when serum phosphate >0.8 mmol/L. (3) Severe deficiency (<0.3 mmol/L): ① Administer via peripheral vein: 0.16 mmol/kg phosphate over 6 hours. For patients with severe symptoms, increase the dose to 0.24 mmol/kg. ② Recheck serum phosphate concentration 6-12 hours after infusion, with repeated checks as needed. ③ Check serum phosphate levels daily. Discontinue infusion when serum phosphate >0.8 mmol/L. Maximum intake of 50 mmol/L phosphate within 24 hours. For patients with severe hypophosphatemia complicated by refeeding syndrome, intravenous administration of 50 mmol phosphate over 6-12 hours is recommended [20, 21].	Level 2	B
	Serum Potassium 14. (1) Mild deficiency (3.0-3.5 mmol/L): Supplement with 20 mmol potassium via enteral or peripheral venous route. (2) Moderate deficiency (2.5-3.0 mmol/L): ① Supplement with 20-40 mmol potassium via enteral or peripheral venous route. ② Check serum potassium levels 8 hours after infusion. ③ If serum potassium is not corrected to normal, supplement an additional 20 mmol potassium. ④ Check serum potassium 4 hours after the last administration; repeat step 3 as needed until serum potassium returns to normal. (3) Severe deficiency (<2.5 mmol/L): ① If the patient cannot supplement potassium via enteral route or has severe hypokalemia, supplement 40 mmol potassium via peripheral vein. ② Check serum potassium 8 hours after infusion. ③ If serum potassium is not corrected to normal, repeat step 1 until normalized. In severe cases, supplement up to 80 mmol potassium. ④ If serum potassium <3.3 mmol/L, check serum magnesium levels. ⑤ Infusion rate should generally not exceed 10 mmol/h [10, 21].	Level 3	A
	Serum Magnesium 15. (1) Mild deficiency (0.5-0.7 mmol/L): Supplement with 20-24 mmol magnesium daily via enteral or peripheral venous route; administer in divided doses to reduce diarrhea, for at least 5 days. (2) Moderate or severe deficiency (<0.5 mmol/L): ① Administer 10 mL of 50% magnesium sulfate injection (5 g/10 mL) daily via peripheral vein, diluted with 500 mL 0.9% NaCl. Adjust the infusion rate based on serum magnesium levels, infuse over >5 hours, for 3-5 days. ② Combine with enteral magnesium supplementation to maintain normal serum levels. ③ Check serum magnesium levels 6-8 hours after intravenous magnesium administration. ④ The general intravenous magnesium supplementation rate should not exceed 150 mg/min. Daily magnesium intake should not exceed 40 mmol [21].	Level 3	A
	Serum Sodium 16. (1) For low-risk patients, sodium intake is not restricted. (2) For high-risk patients, sodium intake should be <1 mmol/(kg·d) during days 1-7 of nutritional therapy. (3) For extremely high-risk patients, sodium intake should be <1 mmol/(kg·d) during days 1-10 of nutritional therapy [9, 21].	Level 3	A
	Serum Iron 17. Even in patients with iron deficiency, iron supplements should not be used within the first 7 day [21].	Level 3	A
	Vitamins 18. Patients at risk of refeeding syndrome should receive adequate multivitamins for 10 days or longer [21].	Level 3	B
	Total Fluid Intake 19. (1) Low-risk patients: No fluid intake restriction. (2) High-risk patients: Days 1-3: 25-30 mL/(kg·d). (3) Extremely high-risk patients: Days 1-3: 20-25 mL/(kg·d); Days 4-6: 25-30 mL/(kg·d) [13,14].	Level 2	A
Prevention and Management Strategies	Monitoring System 20. Laboratory indices including phosphorus, potassium, magnesium, sodium, calcium, prealbumin, albumin, glucose, urea, serum creatinine, and vitamin B1 should be closely monitored in patients at risk of RFS [8-12].	Level 3	A
	21. Clinical status of patients at risk of RFS, including body weight, intake-output, edema severity, cardiopulmonary function, and vital signs, should be closely monitored [10-14].		
	MDT Collaboration 22. Establish a multidisciplinary nutritional support team including physicians, nurses, dietitians, pharmacists, etc. Team members should receive education and training matching their roles to assess patient risk grades and implement personalized intervention plans [18-20].	Level 2	A

Management of Special Populations 23. Diabetes mellitus complicated with RFS: Combine enteral nutrition (EN) with insulin for blood glucose control [18].	Level 2	B
RFS Management 24. ① For patients with mild or moderate RFS, immediate comprehensive treatment for RFS is required, including prompt correction of electrolyte disorders, supplementation of trace elements, and appropriate extension of nutritional therapy by 12-24 hours. ② For patients with severe RFS (marked RFS accompanied by clinical symptoms such as edema, pulmonary failure, or heart failure), clinical symptoms should be fully treated, electrolyte levels closely monitored. After electrolyte levels normalize, initiate low-calorie feeding and implement cautious fluid management [8-10, 17, 18].	Level 3	A

Table 6. Review indicators and methods for evidence-based nursing of RFS

Best Evidence	Review Indicator	Review Content	Review Method
Evidence 1	1. Implementation rate of NRS 2002 combined with phosphorus, magnesium, potassium tests	Medical records, nursing notes, laboratory reports	Review whether NRS 2002 scoring and phosphorus/magnesium/potassium test records were completed within 24 hours of admission.
Evidence 2, 4	2. Identification rate of high-risk populations (BMI <16 kg/m^2, weight loss >15%, low albumin/prealbumin)	Nutrition assessment forms, nursing records	Verify whether high-risk factors (BMI, weight change, albumin levels) are completely recorded in medical records.
Evidence 3, 4	3. Accuracy of risk stratification (low/high/extremely high risk)	Nutrition assessment forms, physician evaluation records	Check whether risk stratification meets standards (BMI, weight loss ratio, fasting duration, etc.).
Evidence 5	4. Proportion of ICU patients without contraindications initiating EN within 24-48 hours	Medical order records, EN initiation time records	Statistic the proportion of ICU patients with EN initiation time ≤48 hours.
Evidence 6, 10	5. Compliance with initial calorie (10-20 kcal/kg/d) and target calorie increment	Nutrition prescriptions, nursing records	Verify whether calories in nutrition prescriptions gradually increase according to risk stratification (low/high/extremely high risk).
Evidence 7	6. Utilization rate of EN priority over PN	Medical order records, nutrition route selection records	Statistic the proportion of patients without contraindications using EN (vs. PN).
Evidence 8, 9	7. Proportion of high-risk patients (e.g., hypophosphatemia) initiating EN after electrolyte correction	Laboratory reports, EN initiation time records	Verify whether patients with serum phosphorus <0.3 mmol/L initiated EN after correction to safe levels.
Evidence 11	8. Whether protein intake starts at low dose (<0.8 g/(kg·d)) and gradually increases to target (≥1.2-1.3 g/(kg·d))	Nutrition prescriptions, nursing records	Check if protein starts at <0.8 g/(kg·d) and gradually increases to ≥1.2-1.3 g/(kg·d).
Evidence 12	9. Standardization of thiamine (B1) supplementation (dosage, timing)	Medical order records, medication administration records	Verify whether high-risk patients received B1 (200-300 mg/d) 30 minutes before EN.
Evidence 13-15	10. Compliance with graded supplementation of electrolytes (phosphorus, potassium, magnesium) according to deficiency severity	Medical order records, laboratory re-examination reports	Check if supplementation plans for hypophosphatemia/hypokalemia/hypomagnesemia patients conform to mild/moderate/severe deficiency standards.

Evidence 16	11. Compliance with sodium intake restriction (high-risk/extremely high-risk patients)	Nutrition prescriptions, nursing records	Verify whether sodium intake of high-risk patients was ≤1 mmol/(kg·d) during days 1-7.
Evidence 17	12. Implementation rate of iron supplement prohibition within the first 7 days	Medical order records, medication use records	Check if iron supplements were avoided within the first 7 days for RFS-risk patients.
Evidence 18	13. Implementation rate of multivitamin supplementation for ≥10 days	Medical order records, nutritional support plans	Verify whether multivitamin prescriptions were issued and continued for ≥10 days.
Evidence 19	14. Compliance with fluid management (high-risk/ extremely high-risk patients)	Nursing records, intake-output records	Check if fluid intake of high-risk patients was controlled at 25-30 mL/(kg·d) during days 1-3.
Evidence 20, 21	15. Compliance rate of laboratory index monitoring (serum phosphorus, potassium, magnesium, vitamin B1, etc.) and clinical status (body weight, intake-output, edema severity, cardiopulmonary function, vital signs, etc.) for RFS-risk patients	Laboratory reports, medical order records	Statistics show the daily monitoring proportion of serum phosphorus, potassium, magnesium, etc. in high-risk patients and the frequency of ≥3 times per week after reaching the standard.
Evidence 22	16. Proportion of nutritional plans developed by multidisciplinary team (MDT)	MDT meeting records, nutritional plan signing documents	Verify whether high-risk patients' plans were jointly developed by MDT (physicians, dietitians, nurses).
Evidence 23	17. Proportion of diabetic patients with RFS using EN combined with insulin for glycemic control	Diabetes management records, insulin use records	Check if diabetic patients with RFS adopted EN combined with insulin.
Evidence 24	18. Standardization of delayed nutritional therapy and fluid management for severe RFS patients	Nursing records, medical order records	Verify whether severe RFS patients initiated low-calorie feeding and strict fluid management after electrolyte normalization.

quate mastery of electrolyte monitoring and correction skills, coupled with a lack of rapid detection equipment and standardized operation procedures; ④ Patients' insufficient awareness of refeeding syndrome risks, due to the absence of individualized education materials and interactive education; ⑤ Lack of systematic RFS prevention and management training in the hospital, resulting in nurses' insufficient mastery of risk stratification and clinical assessment skills.

Evidence-based practice

From March 1 to April 30, 2025, the team analyzed barrier factors one by one according to the aspects of manpower, machinery, materials, methods, and environment, formulated corresponding action strategies, and carried out clinical quality improvement. The specific measures are as follows.

System improvement

The Clinical Practice Guidelines for the Prevention and Management of ICU-Related Refeeding Syndrome were incorporated into the core rules and regulations of the ICU department. The core evidence-based components integrated into the guidelines include the following six modules:

① Early screening and assessment: Combined screening with the Nutritional Risk Screening 2002 (NRS 2002) tool and biochemical indicators (serum phosphorus, magnesium, potassium); stratification of risk factors; and determination of risk grades.

② Basic principles of nutritional support: Priority of enteral nutrition (EN); initial calorie supply of 10-20 kcal/kg/d; and superiority of EN over parenteral nutrition (PN) in reducing infection risk and intestinal function injury.

③ Timing of EN initiation: Initiation of EN within 24-72 hours after hemodynamic stabilization; correction of hypophosphatemia prior to EN initiation in patients with this condition.

④ Standards for nutritional intake: Stratified supply of calories and proteins; pre-supplementation of thiamine; and individualized supplementation of electrolytes.

⑤ Establishment of a monitoring system: Close monitoring of laboratory indicators and clinical status.

⑥ Prevention and management strategies: Multidisciplinary team (MDT) collaboration; management of special populations; and graded treatment of RFS.

Establishment of a multidisciplinary team (MDT) and clarification of job responsibilities

In accordance with the evidence-based requirements, an ICU RFS nutritional support MDT was established to clarify the core responsibilities of each member, ensuring clear division of labor and smooth collaboration. The composition of the team and respective responsibilities are detailed as follows:

① Leaders: Chief physician/head nurse of the ICU - Responsible for the overall promotion of evidence translation, system formulation, human resource coordination, and supervision of practical implementation.

② Core executors: ICU physicians - Responsible for determining RFS risk grades, formulating nutritional support plans (EN/PN), making decisions on the timing of EN initiation, and conducting graded treatment of RFS.

③ Frontline executors: ICU primary nurses - Responsible for RFS screening and re-screening, sampling and monitoring of laboratory indicators, observation of clinical status (e.g., body weight, fluid intake and output), implementation of nutritional support (e.g., EN infusion, electrolyte supplementation), documentation, and reporting of abnormalities.

④ Professional supporters: Clinical dietitians - Responsible for NRS 2002 scoring, formulating individualized nutritional prescriptions (calories/proteins/electrolytes), and evaluating the effectiveness of nutritional support.

⑤ Auxiliary supporters: Pharmacists - Responsible for reviewing the dosage of drugs such as thiamine, electrolytes, and vitamins, guiding infusion routes, and assessing drug-drug interactions; Clinical laboratory technicians - Responsible for rapid detection of indicators such as electrolytes and albumin, and timely feedback of results.

Hierarchical training to improve staff's evidence awareness and executive ability

Hierarchical and module-specific evidence-based training was conducted based on the

responsibilities of different executors, avoiding "one-size-fits-all" training to ensure pertinence and effectiveness. The key points of the training are as follows:

① Training content: Divided according to the responsibilities of the MDT members. For example, nurses received focused training on screening processes, monitoring standards, and documentation methods; physicians on risk grade determination, formulation of nutritional plans, and RFS treatment; and dietitians on the formulation of individualized nutritional prescriptions and stratified calorie supply.

② Training methods: A combination of "theoretical lectures + case simulation + practical assessment" was adopted. Based on real ICU RFS cases, scenarios such as identification of high-risk groups, electrolyte supplementation, and decision-making on EN initiation timing were simulated to enable immersive mastery of operational standards.

③ Training assessment: Closed-book theoretical examinations and practical assessments were conducted after training. Theoretical examinations focused on evidence points and operational standards, while practical assessments focused on screening processes and electrolyte supplementation operations. Only those who passed the assessment were allowed to participate in evidence-based practice, ensuring that the awareness rate of medical staff reached ≥95%.

Development of a standardized RFS management process based on the whole clinical course of ICU patients

Taking the whole clinical course of ICU patients from admission to discharge/transfer as the axis, the RFS management evidence was translated into specific clinical behaviors, forming a standardized RFS management process. The core process is as follows:

① Admission phase: Screening and risk grading. Within 2 hours after admission to the ICU, the primary nurse completed the NRS 2002 scoring and detection of serum phosphorus, magnesium, and potassium, and filled out the RFS Screening and Assessment Form. The clinical dietitian completed the review within 24 hours. Physicians determined the patient's risk grade (low/high/very high) according to the risk factor and risk grade criteria, marked it in the medical record and nursing documentation, and initiated MDT consultation for patients with very high risk.

② Hospitalization phase: Nutritional support and dynamic monitoring. Nutritional support: For patients without contraindications, physicians issued EN orders within 24-72 hours after hemodynamic stabilization. Clinical dietitians formulated stratified calorie/protein supply plans according to the risk grade. Nurses initiated EN in accordance with the orders (initial 10-20 kcal/kg/d) with gradual escalation. For patients with hypophosphatemia, physicians first issued orders for electrolyte correction, and EN was initiated after the indicators reached the normal range.

Routine re-screening: Primary nurses completed RFS re-screening (NRS 2002 + biochemical indicators) once a week and updated the risk grade in a timely manner.

Close monitoring: Laboratory indicators: Serum phosphorus, magnesium, and potassium were detected daily in low/high-risk patients, and every 6-12 hours in very high-risk patients until the indicators were normalized. Clinical status: Nurses recorded fluid intake and output and vital signs every 4 hours, monitored body weight and edema degree daily, and evaluated cardiopulmonary function weekly.

Nutrient supplementation: Nurses supplemented thiamine 30 minutes in advance as prescribed, completed individualized supplementation of phosphorus, potassium, and magnesium in accordance with the Quick Reference Manual for Electrolyte Supplementation, rechecked the indicators at the specified time points after supplementation, and adjusted the dosage timely.

③ Intervention phase: Graded treatment of RFS and management of special populations. In the event of RFS, physicians issued treatment orders according to mild/moderate/severe grading: For mild/moderate RFS patients, electrolyte correction was performed immediately, and nutritional therapy was extended by 12-24 hours; For severe RFS patients (with obvious RFS symptoms accompanied by clinical manifestations such as edema, pulmonary

failure, or heart failure), clinical symptoms were treated first, and low-calorie feeding was initiated after electrolyte normalization. Nurses strictly implemented fluid management.

For patients with diabetes complicated with RFS, physicians issued orders for EN combined with insulin. Nurses closely monitored blood glucose and adjusted the insulin dosage timely.

④ Discharge/transfer phase: Continuous management. Before discharge/transfer, physicians and clinical dietitians re-evaluated the RFS risk of patients. A post-discharge nutritional guidance plan was formulated for low-risk patients, and a transitional nutritional support plan for post-transfer was formulated for high/very high-risk patients to ensure the continuity of RFS management.

Effect evaluation

From October 1 to November 1, 2023, 87 nurses, 23 physicians in the ICU, and 300 ICU patients were enrolled as research subjects. The compliance status of 18 review indicators before and after the application of best evidence was compared. The self-designed "RFS Monitoring Form" was used to compare indicators such as RFS incidence, complication rate, and patient prognosis before and after evidence application, so as to evaluate the effect of evidence-based practice.

Statistical methods

SPSS 27.0 was used for data analysis. Measurement data were expressed as mean ± standard deviation (x±s), and t-test or analysis of variance was used for intergroup comparison; enumeration data were expressed as frequency (%), and chi-square test or Fisher's exact probability method was used for intergroup comparison. *P*-value <0.05 was considered statistically significant.

Ethics approval

This study involves human participants and was approved by the Ethics Committee of Shenzhen Nanshan District People's Hospital (ethics number, ky-2024-051503). Participants gave informed consent to participate in the study before taking part.

Results

Comparison of general data of research subjects

There were no statistically significant differences in gender, age, etc. between the two groups of patients before and after evidence application (P>0.05). See **Table 7**.

Compliance status of 18 review indicators before and after evidence application

The compliance rates of the 18 review indicators for evidence-based nursing of RFS were compared before and after the implementation of evidence-based practice. The results showed that, before the application of evidence, the compliance rates of the 18 indicators ranged from 32.2% to 71.5%, with an overall low level of compliance. After the application of evidence-based measures, the compliance rates of all indicators increased significantly, ranging from 82.8% to 95.4%. Specifically, the compliance rate of Indicator 6 increased from 71.5% to 95.4%, Indicator 2 from 64.4% to 94.3%, Indicator 3 from 68.2% to 93.7%, Indicator 12 from 67.4% to 93.1%, Indicator 1 from 58.6% to 92.0%, Indicator 13 from 60.3% to 91.8%, Indicator 17 from 55.1% to 90.6%, Indicator 10 from 56.8% to 90.2%, Indicator 4 from 62.1% to 89.7%, Indicator 14 from 51.6% to 89.5%, Indicator 7 from 52.7% to 88.9%, Indicator 9 from 38.5% to 88.4%, Indicator 8 from 48.5% to 87.6%, Indicator 15 from 47.9% to 87.3%, Indicator 5 from 45.9% to 86.2%, Indicator 11 from 43.2% to 85.7%, Indicator 18 from 41.7% to 84.9%, and Indicator 16 from 32.2% to 82.8%. The most substantial improvements were observed in Indicator 16 (from 32.2% to 82.8%, an increase of 50.6%) and Indicator 9 (from 38.5% to 88.4%, an increase of 49.9%). These findings demonstrate that the application of evidence-based nursing effectively standardized clinical practice and significantly improved the compliance of core review indicators for RFS nursing. See **Figure 1**.

Comparison of RFS incidence and complication rates before and after evidence application

After evidence application, the incidence of RFS decreased from 44.55% before application to 36.36%, with a statistically significant

Table 7. Comparison of general data of ICU patients before and after evidence application

Variable	Pre-application Group (n=165)	Post-application Group (n=165)	t/χ^2 test	*P*
Demographic Characteristics				
Age (years, mean ± SD)	68.92 ± 19.10	66.90 ± 19.78	0.943	0.347
Gender (Male/Female, n (%))	92 (55.76)/73 (44.24)	88 (53.33)/77 (46.67)	0.196	0.658
APACHEII Score (mean ± SD)	22.73 ± 8.99	22.89 ± 9.64	-0.159	0.873
BMI (kg/m^2, mean ± SD)	21.34 ± 3.81	21.90 ± 4.12	-1.274	0.204
Serum albumin (g/L, mean ± SD)	32.52 ± 6.24	32.83 ± 6.64	-0.405	0.686
NRS 2002 Score at admission (mean ± SD)	4.02 ± 1.85	3.92 ± 1.98	0.431	0.667
Serum phosphorus (mmol/L, mean ± SD)	1.22 ± 0.36	1.22 ± 0.38	0.063	0.950
Serum magnesium (mmol/L, mean ± SD)	0.86 ± 0.16	0.83 ± 0.17	1.605	0.109
Serum potassium (mmol/L, mean ± SD)	4.02 ± 0.63	4.11 ± 0.61	-1.263	0.207
Underlying Diseases				
Diabetes mellitus	34 (20.61%)	31 (18.79%)	0.172	0.678
Chronic kidney disease	18 (10.91%)	15 (9.09%)	0.303	0.582
Chronic liver disease	12 (7.27%)	10 (6.06%)	0.195	0.659
Heart failure	21 (12.73%)	18 (10.91%)	0.262	0.609
Respiratory failure	30 (18.18%)	27 (16.36%)	0.191	0.662
Type of Nutritional Support				
Exclusive enteral nutrition (EN)	105 (63.64%)	110 (66.67%)	0.334	0.564
EN + parenteral nutrition (PN)	60 (36.36%)	55 (33.33%)		

Table 8. Comparison of changes in main clinical indicators before and after evidence application (n=330)

Evaluation Index	Before Evidence Application	After Evidence Application	χ^2/t value	*P* value
RFS Incidence	44.55% (147/330)	36.36% (120/330)	4.59	0.032
Complication Incidence				
Hypophosphatemia (<0.6 mmol/L)	50.00% (165/330)	40.91% (135/330)	5.50	0.019
Hypokalemia (<3.0 mmol/L)	46.36% (153/330)	38.79% (128/330)	3.87	0.049
Hypomagnesemia (<0.5 mmol/L)	44.24% (146/330)	36.97% (122/330)	4.95	0.026
Clinical Outcome Indicators				
Mechanical ventilation time (days)	7.62 ± 21.06	3.24 ± 5.27	-2.476	0.007
ICU length of stay (days)	12.47 ± 10.82	9.85 ± 9.29	-2.371	0.018
Average hospital stay (days)	15.09 ± 24.10	11.01 ± 14.61	-2.356	0.019
28-day mortality rate	13.64% (45/330)	6.97% (23/330)	6.39	0.011

difference (P<0.05). The incidences of complications such as hypophosphatemia, hypokalemia, and cardiac dysfunction significantly decreased after evidence application, with statistically significant differences (P<0.05).

Comparison of patient prognosis before and after evidence application

After evidence application, patients' mechanical ventilation time, average hospital stay, and ICU length of stay were significantly shortened, with statistically significant differences (P< 0.05). See **Table 8**.

Discussion

Scientific and safety of evidence application

This study systematically summarized the best evidence for the prevention and management of refeeding syndrome (RFS) in ICU patients

based on the JBI evidence translation model, and formulated feasible improvement measures by combining clinical practice. The established MDT collaboration mechanism increased the RFS management compliance rate from 32.2% to 82.8% (P<0.001), which is consistent with the systematic review results of Friedli et al. [15]. It is noteworthy that our MDT model particularly emphasizes the early involvement of dietitians, which is highly consistent with the ESPEN guideline recommendation that "professional assessment must be conducted before nutritional support" for high-risk patients. Consistent with previous studies [4, 5], the findings of this study confirm that early screening for the risk of refeeding syndrome (RFS) and implementation of targeted preventive management in critically ill patients receiving enteral nutrition are of great significance for reducing mortality and improving clinical outcomes. For instance, a cohort study by Zhang et al. [23] involving 357 critically ill patients also demonstrated that timely RFS risk screening and preventive intervention could reduce the incidence of severe RFS and improve the 28-day survival rate. However, this study further highlights the deficiencies in current clinical practice: there is a widespread lack of standardized prevention and management measures for RFS in clinical settings, and numerous barriers exist in clinical work. These barriers include the ease of confounding RFS with other diseases, insufficient mastery of RFS-related knowledge among healthcare professionals, the absence of standardized clinical protocols for RFS prevention and management, and a lack of specialized RFS management teams, among others. International studies [15, 16, 26] on this topic are relatively extensive, yet the research focus varies across the literature, leading to certain discrepancies in the recommendations regarding RFS screening and prevention. In this study, we systematically retrieved evidence related to the early intervention of RFS in critically ill patients receiving enteral nutrition both domestically and internationally, and further screened and integrated the evidence in combination with domestic clinical scenarios and expert opinions. This work provides a theoretical basis and decision-making support for healthcare professionals to conduct early screening and prevention of RFS, thereby enabling more scientific and effective clinical management for patients.

Effectiveness of evidence-based nursing practice

The study showed that strict stepwise nutritional management reduced the incidence of RFS (from 44.55% to 36.36%). The "risk stratification-gradual supply" protocol implemented by our team had three innovations: (1) Reducing the initial calorie intake of extremely high-risk patients (BMI <14 kg/m^2) to 5-10 kcal/kg/d, which significantly mitigated metabolic shock; (2) Adopting a "slow-then-fast" protein increment strategy (<0.8 g/kg/d in the first 3 days, accelerating to 1.3 g/kg/d after day 7), which avoided early excessive supply while ensuring late anabolic needs; (3) Synchronous micronutrient supplementation (especially thiamine) reduced the incidence of electrolyte disorders by 58.7%. These findings provided practical validation for the "individualized refeeding" theory proposed by Reber et al. [3]. The average hospital stay and ICU length of stay were shortened to 11.01 days and 9.85 days, respectively (P<0.05). These results indicated that RFS prevention and management measures based on the JBI evidence translation model had significant clinical effects. Measures such as early screening of high-risk patients, standardized electrolyte monitoring and correction, and implementation of stepwise nutritional management effectively reduced the incidence of RFS and complication risks, thereby improving patient prognosis.

Evidence-based nursing practice improved nurses' operational compliance and standardized nursing behaviors

The evidence for early intervention in refeeding syndrome (RFS) among critically ill patients receiving enteral nutrition summarized in this study provides a systematic and scientific set of RFS risk screening and preventive measures for patients following ICU admission. At present, domestic research on the preventive management of RFS in this patient population is predominantly limited to general therapeutic principles, such as the replenishment of electrolytes and trace elements, fluid and sodium restriction, and low-calorie feeding, with a lack of systematically standardized management protocols and specific therapeutic strategies. This study compiles the best available evidence for RFS risk screening, risk monitoring, preven-

tive measures, as well as RFS identification and management, featuring a clear hierarchical classification of evidence categories and streamlined protocols that facilitate implementation and operation by healthcare professionals.

In this study, RFS risk stratification was performed based on the type and severity of patients' RFS risk factors. On this basis, individualized RFS prevention protocols were developed for critically ill patients receiving enteral nutrition, rendering the interventions more targeted. In addition, the evidence summarized herein is more specific: it provides concrete supplementation guidelines and defined intake ranges for electrolytes, calories, and protein in clinical management. For example, for patients at low risk of RFS, a caloric intake of 15-25 kcal/(kg·d) is recommended on days 1-3 of nutritional therapy, which may be increased to 30 kcal/(kg·d) on day 4, with full target caloric intake achievable from day 5 onwards. Such specific recommendations improve healthcare professionals' compliance with evidence-based practice.

Collectively, the evidence presented in this study offers feasible and practicable measures for the early intervention of RFS for healthcare providers, optimizes the preventive management workflow and enhances nursing efficiency, and thus provides a valuable reference for the development of individualized early intervention protocols for RFS in clinical practice.

Limitations

This study has the following limitations: (1) The single-center design may limit the generalizability of the results; (2) The 6-month follow-up period was insufficient to evaluate long-term nutritional outcomes; (3) Subgroup analysis for different specialized ICUs (such as neuro-ICU and cardiac ICU) was not performed. Future studies should conduct multicenter randomized controlled trials and explore the value of biomarkers (such as prealbumin and insulin-like growth factor-1) in early warning of RFS.

Conclusion

The best evidence-based practices for RFS prevention and management based on the JBI evidence translation model can effectively reduce the incidence of RFS, improve patient prognosis, and enhance nursing quality. Future studies should further expand the sample size, validate the external generalizability of the evidence, and explore more effective prevention and management strategies.

Relevance for clinical practice

Based on the findings of this study, ICU clinical teams (including physicians, nurses, and dietitians) can utilize the JBI Evidence Implementation Framework and the established evidence-based audit criteria to systematically integrate best practices for refeeding syndrome (RFS) prevention and management into daily care. The multidisciplinary collaboration (MDT) model, stepwise nutritional protocol, and closed-loop electrolyte management strategy developed in this project provide a practical and replicable blueprint for other ICUs. Implementing these strategies can enhance early identification of high-risk patients, standardize monitoring and intervention procedures, and ultimately reduce the incidence of RFS and its complications, thereby improving patient safety and clinical outcomes.

Acknowledgements

All authors express the greatest appreciation to the investigators, study coordinators, operation staff and the whole project team who worked on this study. Special thanks to Head Nurse Yuju Qin for her great support in project guidance and data collection. This work was supported by grants from the Shenzhen Nanshan District Health Bureau (Project Number NS2024074), Sanming Project of Medicine in Shenzhen (No. SZSM202403005), Municipal Financial Subsidy of Nanshan District Medical Key Discipline Construction, and Major Science and Technology Project in Healthcare System of Nanshan District Shenzhen (NSZD2025006). This funding provided support in terms of study materials and editorial support.

Disclosure of conflict of interest

None.

Address correspondence to: Dr. Yu-Ju Qin, Department of Critical Care Medicine, Shenzhen Nanshan District People's Hospital, 89 Taoyuan Road, Nanshan District, Shenzhen 518054, Guangdong, China. Tel: +86-13728655208; E-mail: qinyuju61-761@163.com

References

[1] Heuft L, Voigt J, Selig L, Stumvoll M, Schlögl H and Kaiser T. Refeeding syndrome. Dtsch Arztebl Int 2023; 120: 107-114.

[2] Friedli N, Odermatt J, Reber E, Schuetz P and Stanga Z. Refeeding syndrome: update and clinical advice for prevention, diagnosis and treatment. Curr Opin Gastroenterol 2020; 36: 136-140.

[3] Reber E, Friedli N, Vasiloglou MF, Schuetz P and Stanga Z. Management of refeeding syndrome in medical inpatients. J Clin Med 2019; 8: 2202.

[4] Naik NM, Li J, Seres D and Freedberg DE. Assessment of refeeding syndrome definitions and 30-day mortality in critically ill adults: a comparison study. JPEN J Parenter Enteral Nutr 2023; 47: 993-1002.

[5] Adika E, Jia R, Li J, Seres D and Freedberg DE. Evaluation of the ASPEN guidelines for refeeding syndrome among hospitalized patients receiving enteral nutrition: a retrospective cohort study. JPEN J Parenter Enteral Nutr 2022; 46: 1859-1866.

[6] Alper BS and Haynes RB. EBHC pyramid 5.0 for accessing preappraised evidence and guidance. Evid Based Med 2016; 21: 123-125.

[7] Aromataris E, Fernandez R, Godfrey CM, Holly C, Khalil H and Tungpunkom P. Summarizing systematic reviews: methodological development, conduct and reporting of an umbrella review approach. Int J Evid Based Healthc 2015; 13: 132-140.

[8] Singer P, Blaser AR, Berger MM, Calder PC, Casaer M, Hiesmayr M, Mayer K, Montejo-Gonzalez JC, Pichard C, Preiser JC, Szczeklik W, van Zanten ARH and Bischoff SC. ESPEN practical and partially revised guideline: clinical nutrition in the intensive care unit. Clin Nutr 2023; 42: 1671-1689.

[9] Boland K, Solanki D and O'Hanlon C. Prevention and treatment of refeeding syndrome in the acute care setting. Irish Society for Clinical Nutrition & Metabolism 2013: 1-31.

[10] National Collaborating Centre for Acute Care. Nutrition support for adults oral nutrition support. J Parenter Enter Nutr 2006: 53-54.

[11] Chinese Geriatrics Society, Geriatric Medicine Branch of Chinese Medical Doctor Association, Editorial Board of Chinese Journal of Geriatrics. Guidelines for nutritional support therapy in critically Ill elderly patients in China (2023). Chin J Geriatr 2023; 42: 1009-1028.

[12] East Cheshire NHS Trust. Guidelines for prevention and management of refeeding syndrome in adults. (2018-12-01) [2026-01-14]. https://cdn.ncpodcast.net/file/NCPodcast/allegati/nc12-LG-CNSG-2019-Sindrome-da-refeeding.pdf.

[13] Seres D. Nutrition support in critically ill patients: parenteral nutrition [EB/OL]. (2025-03-06) [2025-05-09]. https://www.uptodate.com/contents/zh-Hans/nutrition-support-in-critically-ill-adult-patients-initial-evaluation-and-prescription.

[14] Seres D. Nutritional support for critically ill adult patients with intubation: enteral nutrition. [EB/OL]. (2024-09-03) [2025-05-09]. https://www.uptodate.com/contents/zh-Hans/nutrition-support-in-critically-ill-adult-patients-enteral-nutrition?search=%E8%82%A0%E5%86%85%E8%90%A5%E5%85%BB&source=search_result&selectedTitle=1~150&usage_type=default&display_rank=1#H208-8494083.

[15] Friedli N, Stanga Z, Sobotka L, Culkin A, Kondrup J, Laviano A, Mueller B and Schuetz P. Revisiting the refeeding syndrome: results of a systematic review. Nutrition 2017; 35: 151-160.

[16] Cioffi I, Ponzo V, Pellegrini M, Evangelista A, Bioletto F, Ciccone G, Pasanisi F, Ghigo E and Bo S. The incidence of the refeeding syndrome. A systematic review and meta-analyses of literature. Clin Nutr 2021; 40: 3688-3701.

[17] Matthews-Rensch K, Capra S and Palmer M. Systematic review of energy initiation rates and refeeding syndrome outcomes. Nutr Clin Pract 2021; 36: 153-168.

[18] da Silva JSV, Seres DS, Sabino K, Adams SC, Berdahl GJ, Citty SW, Cober MP, Evans DC, Greaves JR, Gura KM, Michalski A, Plogsted S, Sacks GS, Tucker AM, Worthington P, Walker RN and Ayers P; Parenteral Nutrition Safety and Clinical Practice Committees, American Society for Parenteral and Enteral Nutrition. ASPEN consensus recommendations for refeeding syndrome. Nutr Clin Pract 2020; 35: 178-195.

[19] Zhejiang Medical Association Critical Care Medicine Branch. Expert consensus on clinical practice of parenteral nutrition therapy for critically ill patients in China (2024). Zhonghua Wei Zhong Bing Ji Jiu Yi Xue 2024; 36: 673-680.

[20] China Anti-Cancer Association Committee on Cancer Nutrition, Chinese Medical Association Branch of Parenteral and Enteral Nutrition. Expert consensus on refeeding syndrome in cancer patients. Electronic Journal of Tumor Metabolism and Nutrition 2023; 10: 616-618.

[21] China International Exchange and Promotive Association for Medical and Health Care Clinical Nutrition Health Branch; Chinese Society of Parenteral and Enteral Nutrition; Chinese Nutrition Society Branch of Clinical Nutrition; Chinese Medical Doctor Association Nutritionist Professional Committee. Chinese expert consensus on the application of electrolytes in

parenteral nutrition (2024 edition). Zhonghua Yi Xue Za Zhi 2024; 104: 3110-3122.
[22] Xiong R, Huang H, Wu Y, Wang S, Wang D, Ji Z, Lin Z, Zang N, Pan S and Huang K. Incidence and outcome of refeeding syndrome in neurocritically ill patients. Clin Nutr 2021; 40: 1071-1076.
[23] Zhang W, Zhang SX, Chen SF, Yu T and Tang Y. Development and validation of risk prediction model for refeeding syndrome in neurocritical patients. Front Nutr 2023; 10: 1083483.
[24] Wong G, Pang J, Li YY and Lew C. Refeeding hypophosphatemia in patients receiving parenteral nutrition: prevalence, risk factors, and predicting its occurrence. Nutr Clin Pract 2021; 36: 679-688.
[25] Md Ralib A and Mat Nor MB. Refeeding hypophosphataemia after enteral nutrition in a Malaysian intensive care unit: risk factors and outcome. Asia Pac J Clin Nutr 2018; 27: 329-335.
[26] Brouwers MC, Kho ME, Browman GP, Burgers JS, Cluzeau F, Feder G, Fervers B, Graham ID, Grimshaw J, Hanna SE, Littlejohns P, Makarski J and Zitzelsberger L; AGREE Next Steps Consortium. AGREE II: advancing guideline development, reporting and evaluation in health care. CMAJ 2010; 182: E839-842.
[27] Balshem H, Helfand M, Schünemann HJ, Oxman AD, Kunz R, Brozek J, Vist GE, Falck-Ytter Y, Meerpohl J, Norris S and Guyatt GH. GRADE guidelines: 3. Rating the quality of evidence. J Clin Epidemiol 2011; 64: 401-406.
[28] Guyatt G, Oxman AD, Akl EA, Kunz R, Vist G, Brozek J, Norris S, Falck-Ytter Y, Glasziou P, DeBeer H, Jaeschke R, Rind D, Meerpohl J, Dahm P and Schünemann HJ. GRADE guidelines: 1. Introduction-GRADE evidence profiles and summary of findings tables. J Clin Epidemiol 2011; 64: 383-394.