

# Nutritional Support Strategies for Refeeding Syndrome in ICU Patients: A Review of Current Evidence

Huixian Tang<sup>1,\*</sup>, Yongjun Chen<sup>1,\*</sup>, Bo Li<sup>1</sup>, Liping Yuan<sup>2</sup>, Ruixiang Sun<sup>2</sup>

<sup>1</sup>Graduate School of Wannan Medical College, Wuhu, Anhui, 241002, People's Republic of China; <sup>2</sup>Department of Critical Care Medicine, Yijishan Hospital of Wannan Medical College, Wuhu, Anhui, 241001, People's Republic of China

\*These authors contributed equally to this work

Correspondence: Ruixiang Sun; Liping Yuan, The Affiliated Yijishan Hospital of Wannan Medical College, Wuhu, Anhui, 241000, People's Republic of China, +86 19955353952; +86-13855377237, Email sjs20180530@qq.com; 2087610058@qq.com

**Objective:** This study employed an evidence-based approach to synthesize and integrate relevant evidence regarding early nutritional support for patients with ICU refeeding syndrome, identifying clinically applicable nutritional support strategies to provide a reference for early nutritional management in such patients.

**Methods:** Based on the “6S” pyramid evidence hierarchy model, systematic searches were conducted in core domestic and international databases for guidelines, expert consensus documents, high-quality randomized controlled trials (RCTs), systematic reviews, and evidence summaries related to early nutritional support for ICU refeeding syndrome patients, with the search period spanning from database establishment to December 25, 2025.

**Results:** A total of 16 publications were included, comprising 3 guidelines, 2 clinical decision-making documents, 4 systematic reviews, 2 cohort studies, 1 RCT, and 4 expert consensus documents. The evidence was systematically organized into 24 key evidence-based recommendations covering five aspects: multidisciplinary team collaboration, timing of nutritional assessment, indications for initiating and terminating nutritional support, specific nutritional interventions, and health education.

**Conclusion:** The evidence framework developed in this study provides a standardized reference for early nutritional management of ICU refeeding syndrome patients, addressing the lack of unified clinical guidelines and holding significant implications for reducing complication risks and improving patient outcomes.

**Keywords:** intensive care unit, ICU, refeeding syndrome, nutritional support, evidence review, evidence-based nursing

## Introduction

Nutritional support, as one of the critical interventions in the management of critically ill patients, effectively provides the body with essential energy and nutrients, maintains organ function, and promotes immune repair, serving as a pivotal approach to improving nutritional status and clinical outcomes in ICU patients.<sup>1</sup> However, due to factors such as disease spectrum and clinical treatment requirements, some critically ill patients may develop refeeding syndrome (RFS) during treatment—a metabolic disorder occurring when enteral or parenteral nutrition is reintroduced after prolonged starvation or malnutrition.<sup>2</sup> Clinical manifestations include electrolyte disturbances, abnormal glucose and lipid metabolism, deficiencies in thiamine and other trace elements, and other systemic symptoms;<sup>3</sup> severe cases may lead to multiple organ dysfunction syndrome and mortality. Current studies indicate<sup>4</sup> that the incidence of RFS among ICU patients during nutritional support ranges from 30% to 59%, with a mortality rate as high as 33.9% within six months, posing a significant threat to patient survival. Existing research confirms that RFS is closely associated with energy metabolism imbalance and malnutrition resulting from impaired absorption function, making targeted nutritional interventions a key therapeutic measure.<sup>5</sup> Therefore, developing a safe and effective nutritional support protocol, along with interventions

such as electrolyte correction and supplementation of essential nutrients, constitutes the core strategy for managing RFS and holds substantial practical significance for enhancing the quality of critical care nutrition.<sup>6</sup> Current research on ICU refeeding syndrome (RFS) both domestically and internationally primarily focuses on its epidemiological incidence, risk factors, and early identification.<sup>7,8</sup> However, most studies are limited to current status analyses and risk screening, with insufficient emphasis on early clinical intervention strategies. Moreover, a unified nutritional support protocol and comprehensive management system have yet to be established. Therefore, a scientific, systematic, standardized, and effective nutritional support strategy is of critical importance for patients developing RFS. This study aims to systematically synthesize evidence-based findings on ICU RFS, summarize effective early nutritional support strategies, and establish a standardized clinical management framework to provide evidence-based guidance for critical care clinical nutrition practice.

## Materials and Methods

### Defining the Evidence-Based Question

The study was designed based on the PICOS principles to establish well-defined evidence-based questions. The study population (P) consisted of adult patients in the ICU who developed refeeding syndrome; the intervention (I) involved nutritional support measures for refeeding syndrome in the ICU; the control (C) comprised conventional measures or a blank control; the outcomes (O) included key indicators such as the incidence of refeeding syndrome, nutritional status, and the prevalence of metabolic disturbances; and the study types (S) encompassed guidelines, randomized controlled trials (RCTs), clinical decision-making, expert consensus, systematic reviews, meta-analyses, and evidence summaries. The study has been registered with the Fudan University Evidence-Based Nursing Center under project registration number ES20259574.

### Retrieval Strategy

This study adopts the “6S” pyramid model of evidence resources and follows a top-down order in evidence retrieval. It systematically searches core domestic and international databases, professional organization websites, and Chinese and English guideline websites, such as the U.S. National Guideline Clearinghouse (NGC), the UK National Institute for Health and Care Excellence (NICE) guideline database, databases including PubMed, Web of Science, MedSci, UpToDate, BMJ Best Practice, YimaiTong guideline website, CNKI, and Wanfang, among others. A combination of subject terms and free terms is used. The Chinese search terms are “Intensive Care Unit/ICU/critically ill patients/severely ill patients”,

Refeeding syndrome/hypophosphatemia/nutrition support/nutrition intervention/enteral and parenteral nutrition/feeding intolerance/electrolyte disorders/metabolic disorders

“guidelines/expert consensus/evidence summary/systematic review/randomized controlled trial/best practice”. The English Search term is “Intensive Care Unit/ICU/critical care unit/critically ill”

refeeding syndrome/hypophosphatemia/nutritional support/nutrition intervention/enteral and parenteral nutrition/feeding intolerance/electrolyte imbalance/metabolic disorders

“systematic review/meta-analysis/guideline/evidence summary/consensus/best practice/randomized controlled trial” Taking PubMed as an example, the search query is ((“Intensive Care Unit”[MeSH Terms] OR ICU[All Fields] OR “critical care unit”[All Fields] OR “critically ill”[All Fields]) AND (“refeeding syndrome”[MeSH Terms] OR hypophosphatemia[All Fields] OR “nutritional support”[All Fields] OR “nutrition intervention”[All Fields] OR “enteral and parenteral nutrition”[All Fields] OR “feeding intolerance”[All Fields] OR “electrolyte imbalance”[All Fields] OR “metabolic disorders”[All Fields])) AND (“systematic review”[All Fields] OR meta-analysis[All Fields] OR guideline [All Fields] OR “evidence summar\*”[All Fields] OR consensus[All Fields] OR “best practice”[All Fields] OR randomiz\*[All Fields]) Taking the Chinese database CNKI as an example, the search query is (subject: intensive care unit ICU critically ill patients critically ill patients) AND (subject: refeeding syndrome hypophosphatemia nutritional support

nutritional intervention enteral and parenteral nutrition feeding intolerance electrolyte disorders metabolic disorders) AND (subject: guidelines expert consensus evidence summary systematic review randomized controlled trials best practice). The search period is from the database inception to December 25, 2025.

## Inclusion and Exclusion Criteria for Literature

Inclusion criteria: ① Study subjects were ICU patients meeting diagnostic criteria; ② The research focuses on nutritional support strategies, risk assessment, or interventions for refeeding syndrome in ICU patients; ③ Study types included guidelines, clinical decision-making, systematic reviews, RCTs, expert consensus, etc; ④ The languages of included literature were Chinese or English.

Exclusion criteria: ① Guidelines, systematic reviews, or expert consensus/opinions that have been updated; ② The quality assessment is rated C by AGREE II; ③ Literature that cannot be accessed in full; ④ Duplicate literature; ⑤ Translated or interpreted versions of foreign literature.

## Literature Screening

The literature screening was conducted using a dual-independent screening method. Initially, two researchers—both certified critical care nurses with over five years of clinical nursing experience, who had completed systematic training at the JBI Evidence-Based Nursing Center and held evidence-based practice qualifications, and were proficient in literature retrieval, screening, and quality assessment methods—performed preliminary screening by reviewing titles and abstracts to exclude studies that clearly did not meet the inclusion criteria. Subsequently, full-text reviews were conducted on the remaining studies to rigorously verify compliance with inclusion and exclusion criteria, ultimately determining each study's inclusion status with detailed documentation of exclusion reasons. In case of discrepancies during screening, consensus was reached through group discussions or arbitration by a third-party evidence-based expert. Each exclusion rationale was meticulously recorded, culminating in a PRISMA flowchart. Literature quality assessment was performed independently by two researchers using the appropriate JBI Critical Evaluation Tool tailored to each study type. Disagreements were resolved through discussion or third-party arbitration to ensure objective and reliable evaluation results.

## Criteria for Evaluating Literature Quality

The quality assessment tools employed in this study adhered to unified and standardized principles, with corresponding criteria applied based on the different types of included literature: (1) For guideline quality assessment, the Appraisal of Guidelines for Research and Evaluation (AGREE II)<sup>9</sup> was utilized. This tool comprises 23 items divided into six core domains: ① Scope and purpose, ② Stakeholder involvement, ③ Rigor of formulation, ④ Clarity of expression, ⑤ Applicability, and ⑥ Editorial independence. Prior to assessment, two researchers trained in evidence-based nursing independently completed training and calibration of the AGREE II tool to ensure consistent understanding of the scoring criteria for each item; (2) Systematic reviews, meta-analyses, expert consensus reports, and cohort studies were evaluated using the respective literature quality assessment tools from the Australian JBI Centre for Evidence-Based Healthcare (2016 edition);<sup>10,11</sup> (3) Clinical decisions retrieved from Uptodate were automatically classified as high-quality evidence and not assessed separately; clinical decisions from other databases were traced back to their original source literature and evaluated using the corresponding JBI literature quality assessment tool (2016 edition).

## Literature Quality Control Process

The literature quality assessment was independently conducted by researchers trained by the Fudan University Evidence-Based Nursing Center. Each literature was evaluated independently by two researchers with professional qualifications in evidence-based nursing; the researchers reviewed each article and extracted evidence. In case of discrepancies during the assessment process, these were resolved through consultation or arbitration by a third party. The final literature quality grade was determined by synthesizing the evaluation results of all entries.

## Evidence Description and Summary

The evidence synthesis adhered to the principles of “priority by hierarchy, categorized integration, and clinical relevance,” prioritizing studies with higher methodological quality. Evidence on the same topic was classified and summarized by study type; in cases of conflicting conclusions, higher-grade evidence was adopted, with final conclusions derived from heterogeneity analysis. Two intensive care nurses with systematic evidence-based nursing training and professional qualifications extracted and synthesized evidence from the 16 selected literature articles. Standardized data extraction forms were used to independently obtain basic literature information, study participant characteristics, intervention measures, and outcome indicators. Evidence on the same topic was further categorized by study type, and the JBI Evidence-Based Healthcare Center (2014 edition) pre-classification system was employed to assess evidence strength. Consistency of evidence was evaluated by comparing the direction of study conclusions; conflicting conclusions were resolved by prioritizing higher-grade evidence, ultimately forming a rigorous evidence framework.

## Evidence Classification and Recommendation Levels

This study employed the 2014 edition of the Australian JBI Evidence-Based Healthcare Centre Evidence Classification and Recommendation Levels System<sup>12</sup> to classify the included evidence, categorizing evidence levels into grades 1–5 (with grade 1a being the highest and grade 5c the lowest). Two researchers independently evaluated and graded the included evidence; in cases of disagreement, hospital-based evidence experts were consulted to resolve the discrepancy. When conflicting evidence was encountered, the evidence with the higher classification level was prioritized.

## Results

### General Characteristics of the Included Literature

A preliminary literature search yielded 4,031 articles. After removing duplicates using literature management software, 3,133 articles remained. Following review of titles and abstracts, 154 articles were selected. Upon full-text review, 138 articles that did not meet inclusion criteria or were of low quality were excluded, leaving 16 final included articles. These comprised 3 guidelines,<sup>13–15</sup> 2 clinical decision-making studies,<sup>16,17</sup> 4 systematic reviews,<sup>18–21</sup> 2 cohort studies,<sup>22,23</sup> 1 randomized controlled trial (RCT),<sup>24</sup> and 4 expert consensus reports.<sup>5,25–27</sup> The literature screening process is illustrated in [Figure 1](#), and the basic characteristics of the included articles are presented in [Table 1](#).

## Incorporation of Literature Quality Evaluation Results

### Results of Guideline Quality Evaluation

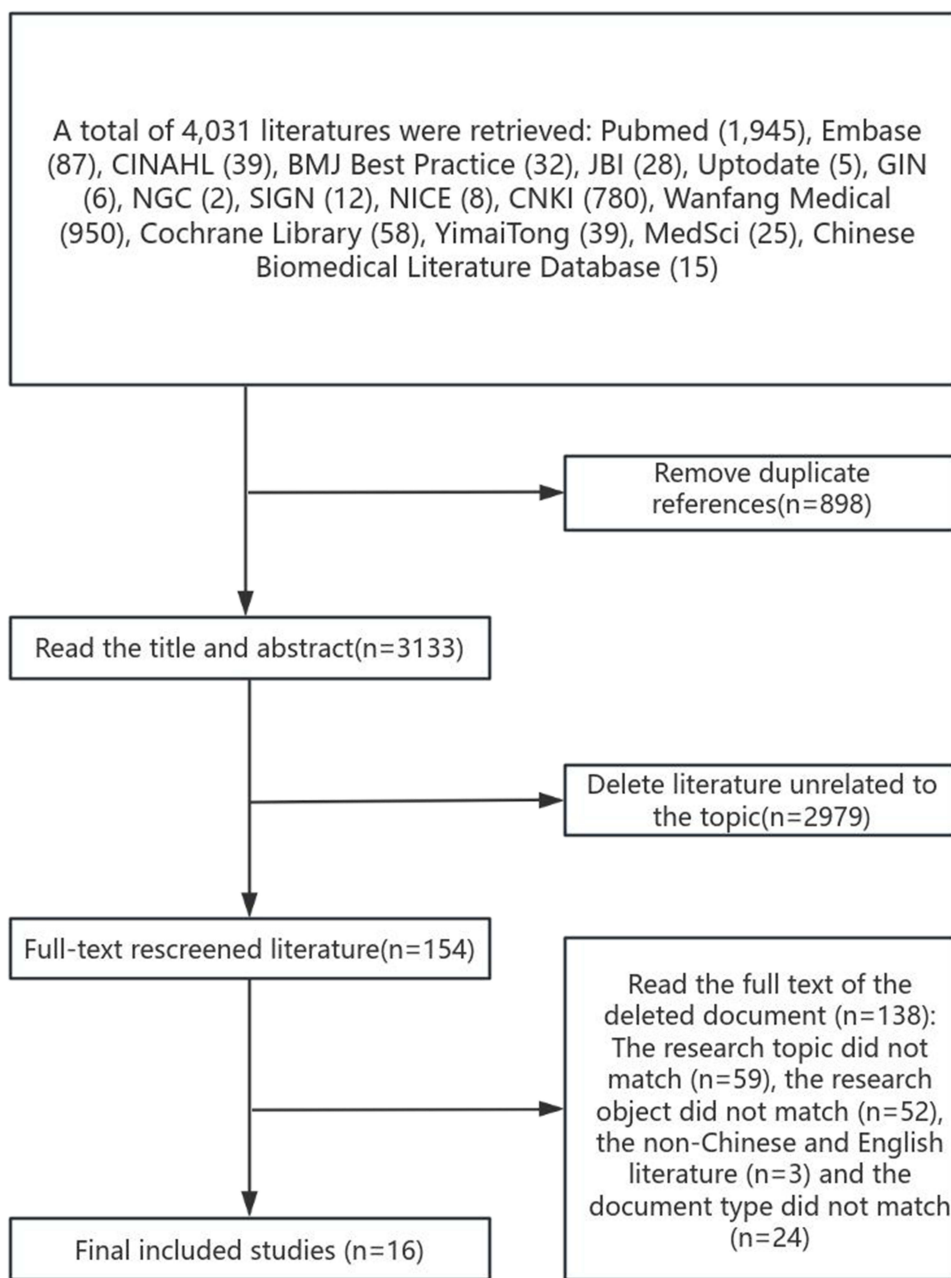
This study evaluated the quality of the three included guidelines according to the AGREE II guideline assessment criteria, covering six aspects such as scope and purpose, and participants. The scores and recommended levels for each domain are detailed in [Table 2](#).

### Systematic Review Analysis of Quality Evaluation Results

This study conducted a methodological quality assessment of the four included systematic reviews using the quality evaluation criteria of the Australian Centre for Evidence-Based Healthcare (JBI), evaluating item compliance across 11 dimensions such as research questions, literature inclusion, and search strategies. The results indicate that the majority of literature items demonstrated satisfactory compliance, with overall research methods being relatively standardized. Detailed evaluation findings for each systematic review are presented in [Table 3](#).

### Results of Quality Evaluation for Cohort Studies

Using the Australian Journal of Biomedical Research (JBI) cohort study quality assessment tool, a methodological quality evaluation was conducted on the two included studies. The standardization of research methods was assessed item-by-item based on 11 core criteria. The evaluation results indicated that the overall quality of the included cohort studies was acceptable, with only one study demonstrating deficiencies in confounding factor management. The specific criterion compliance is detailed in [Table 4](#).



**Figure 1** Literature Screening Process.

### Quality Evaluation Results of Randomized Controlled Trials

The study included one randomized controlled trial (RCT).<sup>24</sup> The literature review indicated that only the evaluation criteria regarding blinding of participants and blinding of interveners received a “no” rating, while all other criteria were rated “yes.” This study was deemed of high quality and was therefore included.

### Results of Expert Consensus Quality Evaluation

Among the four expert consensus articles included in the study,<sup>5,25–27</sup> all literature evaluation entries were rated as “yes,” indicating high overall quality; thus, they were included.

**Table 1** Basic Characteristics of Included Literature (n=16)

Author	Date of Publication	Article Source	Nature of the Article	Topic of the Article
NICE et al <sup>13</sup>	2017	PubMed	Guideline	Nutritional therapy for adults: oral, enteral, and parenteral nutrition
NHS et al <sup>14</sup>	2018	PubMed	Guideline	Guidelines for the Prevention and Management of Adult Refeeding Syndrome
Singer et al <sup>15</sup>	2018	PubMed	Guideline	Clinical Nutrition Guidelines for ICU
Liu et al <sup>16</sup>	2022	Web of science	Expert decision	Discriminative value of SNAQ, GLIM, mNICE and ASPEN in high-risk patients for RFS
Friedli et al <sup>17</sup>	2020	PubMed	Expert decision	Evidence on the incidence, risk factors, and strategies for preventing refeeding syndrome in RFS
Liu et al <sup>18</sup>	2022	PubMed	Systematic review	The effect of caloric intake and refeeding syndrome on hospitalization duration: a meta-analysis
Kylie et al <sup>19</sup>	2020	PubMed	Systematic review	Systematic Evaluation of Energy Activation Rate and RFS Results
Pan Shiwan et al <sup>20</sup>	2025	CNKI	Systematic review	Meta-analysis of influencing factors of refeeding syndrome in ICU patients with enteral nutrition
Ma Huiying et al <sup>21</sup>	2022	CNKI	Systematic review	Meta-analysis of the relationship between refeeding syndrome and prognosis in critically ill patients
Elena et al <sup>22</sup>	2022	PubMed	Cohort study	Is the risk of RFS a concern in meeting nutritional needs? A group of patients receiving enteral nutrition support
Edem et al <sup>23</sup>	2022	PubMed	Cohort study	ASPEN Guidelines for the Evaluation of RFS in Patients Receiving enteral nutrition
Doig et al <sup>24</sup>	2015	PubMed	RCT	Comparison of Restricted and Standard Caloric Intake in the Treatment of Refeeding Syndrome in Critically Ill Patients
Sun Renhua et al <sup>25</sup>	2018	CNKI	Expert consensus	Expert Consensus on enteral nutrition for Severe Patients
Society for Parenteral and Enteral Nutrition of Australia and New Zealand <sup>26</sup>	2025	PubMed	Expert consensus	Identification and Management of Refeeding Syndrome
American Society for Parenteral and Enteral Nutrition (ASPEN) <sup>5</sup>	2020	PubMed	Expert consensus	ASPEN consensus on refeeding syndrome opinion
Priser et al <sup>27</sup>	2021	PubMed	Expert consensus	Guidelines for Enteral Nutrition in Intensive Care Units: Ten Expert Consensus

## Clinical Decision Evaluation Results

Among the two clinical decision-making studies<sup>16,17</sup> included in the review, all literature evaluation entries yielded a “yes” response, indicating high overall literature quality, and both were thus included. This evaluation did not trace back to the original studies cited in the literature; instead, it conducted a quality assessment solely on the included studies themselves, which consisted of a prospective observational study and a review article.

**Table 2** Quality Evaluation Results of the Guidelines (n=3)

Include in Guidelines	Standardization Percentage (%) by Field						$\geq 30\%$	$\geq 60\%$	Recommend
	Scope and Purpose	Participant	Preciseness	clarity	Practicability	Independent Character	Domain Number (individual)	Field number (individual)	Rank (level)
NICE et al <sup>13</sup>	99.4	22.8	77.8	83.3	61.1	68.3	5	5	A
NHS et al <sup>14</sup>	75.5	65.8	64.2	78.9	65.7	87.4	6	6	A
Singer et al <sup>15</sup>	83.3	81.5	66.0	79.6	29.2	94.4	5	5	B

**Table 3** Systematic Review Quality Results (n=4)

Inclusion in Systematic Review	①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩	⑪
Liu et al <sup>18</sup>	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Kylie et al <sup>19</sup>	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Pan Shiwan et al <sup>20</sup>	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Ma Huiying et al <sup>21</sup>	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes

**Note:** ① Are the proposed evidence-based questions clear and well-defined? ② Are the literature inclusion criteria appropriate for these evidence-based questions? ③ Is the search strategy suitable? ④ Are the databases or resources used for literature retrieval sufficient? ⑤ Are the adopted literature quality assessment criteria appropriate? ⑥ Was the literature quality assessment conducted independently by two or more evaluators? ⑦ Were specific measures taken during data extraction to minimize errors? ⑧ Is the method for integrating studies appropriate? ⑨ Was the potential for publication bias assessed? ⑩ Are the proposed policy or practice recommendations based on the systematic review findings? ⑪ Are the suggested directions for further research appropriate?

**Table 4** Quality Assessment Results of the Cohort Study (n=2)

Evaluation Items	Evaluation Results	
	Elena et al <sup>22</sup>	Edem et al <sup>23</sup>
1. Are the two groups of study subjects from the same population?	Yes	Yes
2. Were the same methods used to assess the exposure factors in both groups?	Yes	Yes
3. Are effective and reliable methods used to measure exposure?	Yes	Yes
4. Were confounding factors identified?	Yes	Yes
5. Have measures been taken to address confounding factors?	No	Yes
6. Did the study subjects not exhibit the observed outcome at the initiation of the study/exposure?	Yes	Yes
7. Are effective and feasible methods used to measure the results?	Yes	Yes
8. Was the follow-up duration reported, and was it sufficient to obtain the occurrence of the outcome?	Yes	Yes
9. Is the follow-up complete? If not, describe and investigate the reasons for the loss of follow-up.	Yes	Yes
10. Have measures been taken to address incomplete follow-ups?	Yes	Yes
11. Is the data analysis method appropriate?	Yes	Yes
Comprehensive evaluation	Bring into	Bring into

## Summary of Optimal Evidence

The relevant content from the included literature was extracted and summarized. The 2014 edition of the JBI Evidence-Based Healthcare Center Evidence Pre-classification and Evidence Recommendation Levels System was employed to evaluate and grade the included evidence. The evidence levels were categorized as levels 1–5: Level 1 represented systematic reviews and high-quality randomized controlled trials; Level 2 represented cohort studies; Level 3 represented case-control studies; Level 4 represented cross-sectional studies and quasi-experimental studies; Level 5 represented expert opinions, case reports, and experience summaries. Based on the evidence's feasibility, relevance, clinical significance, and validity, the recommendations were classified as Level A (strong recommendation) or Level B (weak recommendation). A total of 24 relevant pieces of evidence were identified, detailed in [Table 5](#).

**Table 5** Summary of Evidence on Nutritional Support for ICU Refeeding Syndrome

Item	Evidence Summary	Recommendation	Evidence Level
Multidisciplinary team collaboration	1. Nutritional support management for refeeding syndrome requires a multidisciplinary collaborative approach. <sup>13,26,27</sup>	B	3
	2. Multidisciplinary teams comprising clinicians, dietitians, nurses, and pharmacists jointly develop individualized plans, <sup>19,26,27</sup> particularly in caloric initiation, electrolyte supplementation, and nutritional pathway selection.	B	3
Assessing Timing and Tools	3. Timing: Complete the first comprehensive evaluation within 12 hours after RFS diagnosis, including electrolyte levels, organ function, nutritional status, and clinical symptoms (eg., edema, tachycardia), to establish the foundation for initial caloric restriction and electrolyte supplementation plans. <sup>5,13</sup>	B	3
	4. Assessment Tools (1) Acute Physical and Chronic Health Status (APACHE II): This scale evaluates the severity of critical illness in patients. Higher scores indicate increased risk of RFS (renal failure) and can predict RFS-related organ complications (eg., respiratory failure). <sup>15,21,24,25,27</sup>	A	I
	(2) Sequential Organ Failure Assessment (SOFA): This scale evaluates the degree of organ dysfunction (respiratory, circulatory, hepatic, renal, etc). A SOFA score $\geq 6$ indicates an increased risk of RFS and is associated with delayed recovery from RFS. <sup>15,21,24,25,27</sup>	A	I
	(3) Serum biochemical index panel: Objectively reflects metabolic disturbances and nutritional reserves associated with RFS, serving as the core tool for RFS diagnosis and therapeutic monitoring. <sup>5,13,14,19,20,24,25</sup>	A	I
	5. Identification of risk factors: patients with excessively rapid feeding rate, excessive caloric/protein intake, improper feeding routes, advanced age, underlying diseases with poor nutritional reserves, and high APACHE II score and SOFA score. <sup>13,17,19,25</sup>	A	I
Indications for initiation and termination of nutrition	Indications for initiation 6. Correction of electrolyte disturbances: serum phosphorus $\geq 0.8$ mmol/L, potassium $\geq 3.5$ mmol/L, and magnesium $\geq 0.7$ mmol/L, with sustained stability for $\geq 24$ hours; severe refeeding syndrome (RFS) requires stabilization for $\geq 48$ hours without rebound tendency. <sup>5,24–26</sup>	B	3
	7. Clinical symptoms associated with RFS remission: absence of sodium and water retention (edema resolution), tachycardia, dyspnea, delirium, etc., with blood oxygen saturation $\geq 90\%$ (no need for mechanical ventilation or reduced dependence), and absence of thiamine deficiency-related manifestations. <sup>5,14,15</sup>	B	5
	8. Stable underlying condition: The primary disease shows no deterioration, with infection markers trending toward normal levels; fluid balance is stable, without significant sodium or water retention, and the intake and output are essentially balanced. <sup>5,14,23</sup>	B	3
	Indications for discontinuation 9. Persistent normal nutritional parameters: serum albumin $\geq 35$ g/L, prealbumin $\geq 180$ g/L, and BMI maintained within the normal range; stable body weight without a tendency for further decline. <sup>22,25,26</sup>	B	3
	10. Complete remission with no risk of recurrence: No recurrence of electrolyte disturbances during nutritional support, and disappearance of thiamine deficiency-related symptoms; stable metabolic status with normal blood glucose, blood urea nitrogen (BUN), creatinine, and other indicators. <sup>14,15</sup>	A	I

(Continued)

Table 5 (Continued).

Item	Evidence Summary	Recommendation	Evidence Level
Specific measures for nutritional support	11. Core correction: Prioritize the correction of hypophosphatemia, while simultaneously intervening in hypokalemia and hypomagnesemia; none of these three conditions should be overlooked. <sup>5,13–15,19,23,25–27</sup>	A	I
	12. Correction of disorders and dose supplementation: (1) Serum phosphorus supplementation: ① Mild deficiency (0.6–0.8 mmol/L): Oral or enteral supplementation of 1 g phosphate daily. ② Moderate deficiency (0.3–0.6 mmol/L): Oral/enteral administration of 1 g phosphate daily; or peripheral intravenous infusion at 0.08 mmol/kg within 6 hours, with re-evaluation 6–12 hours post-infusion and repeat if necessary. ③ Severe deficiency (<0.3 mmol/L): Peripheral intravenous infusion at 0.16 mmol/kg within 6 hours, increased to 0.24 mmol/kg for severe cases; re-evaluation 6–12 hours post-infusion, daily monitoring; maximum daily intake within 24 hours is 50 mmol/L, and infusion should be discontinued when serum phosphorus>0.8 mmol/L; for severe RFS, intravenous injection of 50 mmol phosphate may be administered within 6–12 hours. <sup>5,13–15,19,23,25–27</sup>	A	I
	(2) Serum potassium supplementation: ① Mild deficiency (3.0–3.5 mmol/L): Administer 20 mmol potassium ions via enteral or peripheral intravenous routes. ② Moderate deficiency (2.5–3.0 mmol/L): Administer 20–40 mmol via enteral or intravenous routes; recheck after 8 hours of infusion. If the levels are not normal, add 20 mmol and recheck 4 hours after the last dose. <sup>5,13–15,19,23,27</sup>	A	I
	(3) Serum magnesium supplementation: ① Mild deficiency (0.5–0.7 mmol/L): Administer 20–24 mmol daily via enteral or peripheral intravenous routes, divided into doses to reduce diarrhea, for at least 5 days. ② Moderate/severe deficiency (<0.5 mmol/L): Administer 10 mL of 50% magnesium sulfate (5 g/10 mL) via peripheral intravenous route daily, diluted with 500 mL of 0.9% NaCl, with infusion duration>5 hours, for 3–5 days; enteral supplementation may be combined for maintenance; recheck 6–8 hours post-infusion, with daily intake not exceeding 40 mmol. <sup>5,13,15,19,27</sup>	A	I
	13. Strengthen electrolyte monitoring: During the first 3 days after RFS onset, monitor serum phosphorus, potassium, and magnesium 1–2 times daily; for severe cases, monitor every 4–12 hours. After the indicators stabilize, adjust the frequency to once daily for over one week to prevent rebound. <sup>5,13–15,17,19,25</sup>	A	I
	14. Strict caloric control after RFS onset: Upon confirmation of RFS (with hypophosphatemia as the core indicator), immediately interrupt or reduce caloric intake progression. In severe cases, caloric restriction should be limited to 25%–50% of the target value. <sup>13,14,18,20,21</sup>	B	I
	15. Caloric Restoration Grading Scheme: ① Mild/Moderate RFS: After correcting electrolyte imbalances, appropriately extend nutritional therapy for 12–24 hours without significantly reducing caloric intake, advancing at the lower limit of the original risk level. ② Severe RFS (with edema, respiratory/cardiac failure): First thoroughly treat clinical symptoms and closely monitor electrolytes; initiate low-calorie feeding after electrolytes normalize (referencing the starting dose for extremely high-risk populations: 5–10 kcal/(kg d)); subsequently gradually restore to target caloric intake at a rate of “daily increment by 25%”. <sup>13,14,18,21</sup>	B	I
	16. Vitamin B1 supplementation: Adults should receive 100–300 mg daily (oral or intravenous). High-risk individuals (alcohol dependence, neurological symptoms) may increase the dose to 500–1,000 mg per administration (intravenous), for 7–10 days, or until complete resolution of RFS symptoms. <sup>13,14,22,24,27</sup>	A	I
	17. Multivitamin supplementation: For patients receiving parenteral nutrition, administer one multivitamin injection (containing trace elements) daily; for those on oral or enteral nutrition: administer a complete multivitamin once daily for at least 10 days. <sup>5,13,19</sup>	A	I
	18. Enteral nutrition is the first-line option, with pathway switching as needed: Initial rate: 10–20 mL/h, gradually adjusted based on gastrointestinal tolerance (gastric residual volume <500 mL/6 h, absence of vomiting/bloating). Avoid high-glucose and hypertonic formulations; opt for easily digestible formulas when gastrointestinal function is weak. <sup>15,19,20,27</sup>	A	I
	19. Parenteral nutrition: Indicated for gastrointestinal dysfunction (vomiting, intestinal paralysis, severe diarrhea) as a short-term transitional measure. Precautions: Reduce the proportion of pure glucose, supplement with electrolyte solutions, and avoid abrupt insulin elevation. <sup>18–20</sup>	A	I
	20. Mixed feeding: When enteral nutrition is intolerable, parenteral nutrition may be combined to supplement calories, and gradually transition to total enteral nutrition once gastrointestinal function is restored. <sup>18,20</sup>	B	I
	21. Daily regular assessment: Evaluate short-term and long-term nutritional goals daily after nutritional therapy until no additional electrolyte supplementation is required within 2 days, which is considered stable. <sup>5,14,25</sup>	B	5
22. Individualized adjustment: Dynamically adjust the dosage of calories, fluids, and supplements based on electrolyte recovery and clinical symptoms (eg., edema, heart rate). <sup>13,20,25</sup>	B	3	
Health education	23. Nurses should provide psychological counseling to address anxiety caused by nutritional restrictions and prolonged rehabilitation periods, emphasizing the impact of adhering to a standardized regimen on reducing infection risks and improving prognosis. <sup>5,14</sup>	B	5
	24. Instruct patients and their families to strictly adhere to the feeding regimen, refraining from arbitrarily increasing food intake, changing foods, or adjusting feeding speed. Patients who are orally fed should actively report sensations such as appetite and abdominal distension, with family members assisting in recording dietary intake. <sup>5,14</sup>	B	5

## Discussion

### Establishing a Multidisciplinary Team is the Direction for Providing Nutritional Support to Patients

Both the Australian Nutrition Society<sup>26</sup> and ASPEN<sup>5</sup> have explicitly identified multidisciplinary collaboration as the core strategy for RFS nutritional support, advocating for the involvement of a professional team comprising physicians, nurses, clinical dietitians, and pharmacists throughout the entire intervention process. The multicenter randomized controlled trial (RCT) conducted by Doig et al<sup>24</sup> has demonstrated that this physician-nurse-dietitian collaborative nutritional support approach not only significantly reduces the incidence of major infections and 60-day mortality rates in RFS patients but also improves adherence to the nutritional regimen. Compared to traditional single-disciplinary, decentralized models, multidisciplinary teamwork enhances the comprehensiveness of interventions, reduces adverse events, optimizes work efficiency and outcome quality, and better addresses complex clinical challenges through the integration of multidisciplinary expertise and collaborative decision-making.<sup>28</sup> The conclusions of this study are highly consistent with this high-quality evidence, further validating the efficacy of multidisciplinary collaboration in improving RFS patient outcomes. Currently, standardized protocols for multidisciplinary management of RFS remain inadequate in China, with varying levels of collaboration depth and implementation consistency across healthcare institutions.<sup>29</sup> Future efforts should focus on developing standardized multidisciplinary collaboration frameworks tailored to regional healthcare resource characteristics.

### The Timing and Tools for Evaluation are Essential

Appropriate assessment tools and appropriate timing are key evidence-based safeguards for the safe implementation of nutritional support for patients with refeeding syndrome. The comprehensive evidence of this study found<sup>24</sup> that RFS-related assessment must be carried out throughout the entire process of nutritional support, rather than a single screening: the first nutritional risk and RFS high-risk screening must be completed within 24 hours of admission, electrolyte levels monitored every 12 hours for 72 hours after nutritional support is initiated, and a comprehensive assessment completed within 12 hours after the occurrence of RFS. Compared with the previous practice of only a single risk screening before the initiation of nutritional support, standardized assessment throughout the whole process can significantly improve the sensitivity of early identification and reduce the risk of missed diagnosis and complications of RFS. In terms of the selection of assessment tools, some studies have pointed out that the<sup>30</sup> NRS 2002 scale can effectively identify the nutritional risk of ICU patients, and the score of  $\geq 3$  is an independent influencing factor for the occurrence of RFS. SOFA score can accurately judge the degree of organ function damage and provide a basis for the formulation of the starting dose of the nutrition regimen. APACHE II score and SOFA score combined with dynamic monitoring data of blood phosphorus, potassium and magnesium can comprehensively evaluate the patient's organ function status and nutritional support tolerance, and avoid intervention delay or improper feeding caused by insufficient assessment. This comprehensive assessment model can more comprehensively cover the key links of RFS than single-tool screening, and provide an evidence-based path for clinical development of individualized nutritional support plans.

### Nutritional Support for RFS Patients Still Faces Significant Challenges

Refeeding syndrome (RFS) is a metabolic disorder syndrome triggered by the resumption of nutritional intake after prolonged malnutrition, characterized primarily by electrolyte imbalance and organ dysfunction.<sup>31</sup> The initiation and termination criteria for RFS interdependently provide clear clinical guidance for avoiding complications and ensuring the safety of nutritional interventions. The initiation and cessation of nutritional support in RFS patients must simultaneously meet three core criteria: stabilization of electrolyte levels, alleviation of clinical symptoms, and controllable underlying disease status. These criteria are derived from multicenter studies,<sup>24</sup> meta-analyses,<sup>18–21</sup> and consensus guidelines from international authoritative societies.<sup>5,25,26</sup> Their integrated application enables precise timing of nutritional interventions, preventing exacerbation of metabolic disturbances due to premature refeeding and avoiding nutritional deficiencies caused by delayed feeding, thereby supporting standardized management of RFS patients. Traditional RFS intervention criteria primarily focus on energy requirements, organ function, or disease stage, lacking targeted metabolic safety

considerations for high-risk individuals, which may lead to metabolic disturbances or nutritional deficiencies.<sup>32</sup> In contrast, the multidimensional indicator system integrated in this study addresses both the patient's overall condition and the specific metabolic risks associated with RFS, effectively compensating for the limitations of conventional criteria and providing more evidence-based guidance for individualized nutritional support strategies. However, this system is applicable only to specific RFS populations, and some criteria lack quantitative definitions, necessitating further prospective studies to validate its clinical relevance and feasibility.

## Implementing Specific Nutritional Support Measures is Crucial

Caloric adjustment and control constitute the cornerstone of nutritional support following refeeding syndrome (RFS),<sup>33</sup> directly influencing the efficacy of metabolic disorder correction and patient clinical outcomes. Evidence from this study<sup>5,13–15,19,23,25–27</sup> demonstrates that supplementation with phosphorus or thiamine during nutritional therapy effectively prevents refeeding syndrome and hypophosphatemia, while reducing mortality and adverse prognosis risks in high-risk patients. Supplementation of essential nutrients forms the foundation of post-RFS nutritional support,<sup>19</sup> with the selection of appropriate feeding routes based on individual needs ensuring both safety and efficacy of nutrient delivery. This approach must be precisely tailored to the patient's gastrointestinal function, disease severity, and nutritional tolerance. Enteral nutrition remains the most commonly used and recommended pathway,<sup>5</sup> offering superior physiological compatibility and fewer complications, making it suitable for patients with tolerable gastrointestinal function. Further research<sup>5,13</sup> underscores that individualized assessment and adjustment are critical components of post-RFS nutritional support, serving as the cornerstone for achieving a balance between nutrient delivery and physiological tolerance while minimizing treatment deviations. This requires dynamic, comprehensive adaptation tailored to the patient's specific condition.<sup>34</sup>

## Implementing Standardized Health Education is a Key Pathway to Improving Nutritional Support Compliance in Refeeding Syndrome

Implementing standardized health education is an indispensable key component of the comprehensive RFS nutritional support management and a core measure for improving patient outcomes.<sup>35</sup> Nurses should provide psychological counseling addressing anxiety stemming from nutritional restrictions and prolonged rehabilitation periods, emphasizing the impact of adherence to standardized protocols on reducing infection risks and enhancing prognosis. Evidence synthesis from this study<sup>18</sup> demonstrates that systematic health education significantly improves patient and family compliance with nutritional support regimens, reduces RFS recurrence due to unauthorized protocol modifications, and enhances adherence to critical measures such as electrolyte monitoring and medication adherence. Consequently, this approach shortens hospital stays, lowers the incidence of complications like infections, and ensures evidence-based, standardized management of RFS nutritional support.<sup>36</sup>

## Conclusion

This study summarizes the evidence-based evidence regarding nutritional support for ICU refeeding syndrome, covering five aspects: multidisciplinary team collaboration, timing and tools for assessment, indications for initiating and terminating nutritional support, specific measures of nutritional support, and health education. A total of 24 evidence-based recommendations were identified. The studies included in this review exhibited certain heterogeneity in terms of study design, sample size, nutritional support protocols, and outcome measures, with some conclusions being inconsistent. Therefore, when formulating recommendations, we prioritized high-quality evidence with consistent results, providing only qualitative descriptions of controversial conclusions, and advised cautious application based on individual patient circumstances. Currently, the application of multidisciplinary team collaboration, assessment timing and tools, indications for initiating and terminating nutritional support, specific nutritional support measures, and health education in refeeding syndrome still requires further validation and exploration through large-scale, multicenter, high-quality randomized controlled trials. Since most existing studies are based on international guideline consensus and clinical data, there are relatively few specialized domestic studies focusing on ICU patients, elderly patients, or patients with

underlying comorbidities, which may differ from China's actual clinical practices, patient comorbidity profiles, and the availability of nutritional support resources. When applying relevant evidence in clinical practice, it is recommended to comprehensively consider factors such as the severity of the patient's condition, nutritional risk level, gastrointestinal function status, the patient's and family's treatment willingness, and financial capacity to develop safe and appropriate individualized nutritional support management plans. This approach aims to minimize the risk of refeeding syndrome-related complications and improve clinical outcomes. Subsequent research should focus on China's local ICU population and high-risk patients to explore suitable quantitative indicators and management pathways for RFS nutritional support, thereby facilitating the development of localized clinical guidelines.

## Data Sharing Statement

The datasets generated and analysed during the current study are not publicly available but are available from the corresponding author (Liping Yuan) on reasonable request.

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## Disclosure

None of the authors have any conflicts of interest in this work.

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