Evidence Summary for Physical Rehabilitation Treatment of ICU-Acquired Weakness in Older ICU Patients

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Abstract

Objective To integrate the best evidence on physical rehabilitation therapy for ICU-acquired weakness (ICU-AW) in older ICU patients using evidence-based methods, providing an evidence-based basis for standardized assessment and intervention. Methods Relevant domestic and international databases and professional organization websites, including ATS, RNAO, GIN, PubMed, Cochrane Library, CNKI, and Wanfang, were systematically searched to collect guidelines, expert consensuses, randomized controlled trials, systematic reviews, and evidence summaries on physical rehabilitation therapy for older patients with ICU-AW. The search period was from January 2016 to January 2026. Two researchers independently completed literature screening, quality appraisal, and information extraction, and cross-checked the results. The JBI Evidence-Based Health Care Center tools and AGREE were used to assess methodological quality, and the evidence was graded according to the JBI evidence grading system. Results A total of 8 articles were included, comprising 1 guideline, 2 expert consensuses, 1 systematic review, 1 meta-analysis, 1 evidence summary, and 2 RCTs, with overall high quality of evidence. Twenty-seven best-evidence items were summarized across six dimensions: assessment, indications, contraindications, physical therapy modalities, outcome evaluation, and safety monitoring. These items covered core interventions including early mobilization, neuromuscular electrical stimulation, resistance training, inspiratory muscle training, and traditional Chinese medicine physiotherapy, and clarified the timing of initiation, frequency, intensity, sites, and key points for safety monitoring. Conclusion The 27 best-evidence items summarized in this study can provide a standardized evidence-based basis for physical rehabilitation therapy in older patients with ICU-AW. In clinical practice, patient-specific differences and healthcare resource conditions should be considered, multidisciplinary collaboration should be implemented, and evidence should be appropriately translated and applied to improve patients' functional prognosis and quality of life.

Full Text

Evidence Summary for Physical Rehabilitation Treatment of ICU-Acquired Weakness in Older ICU Patients

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【Abstract】**Objective** To integrate, using evidence-based methods, the best evidence on physical rehabilitation treatment for ICU-acquired weakness (ICU-AW) in older ICU patients, and to provide an evidence-based basis for standardized assessment and intervention. **Methods** Relevant domestic and international databases and professional organization websites were systematically searched, including ATS, RNAO, GIN, PubMed, the Cochrane Library, CNKI, Wanfang, and others. Guidelines, expert consensus statements, randomized controlled trials, systematic reviews, and evidence summaries on physical rehabilitation treatment for older patients with ICU-AW were collected. The search period was from January 2016 to January 2026. Two researchers independently completed literature screening, quality appraisal, and information extraction, and cross-checked the results. The JBI Evidence-Based Health Care Center tools and the AGREE II instrument were used to appraise the quality of the literature, and the evidence was graded according to the JBI evidence grading system. **Results** A total of 8 articles were included, comprising 1 guideline, 2 expert consensus statements, 1 systematic review, 1 meta-analysis, 1 evidence summary, and 2 RCTs. Overall, the quality of the evidence was relatively high. Twenty-seven items of best evidence were summarized across six dimensions: assessment, indications, contraindications, physical therapy modalities, outcome evaluation, and safety monitoring. These covered core intervention approaches including early mobilization, neuromuscular electrical stimulation, resistance training, inspiratory muscle training, and traditional Chinese medicine physical therapy, and clarified key points regarding timing of initiation, frequency, intensity, treatment sites, and safety monitoring. **Conclusion** The 27 items of best evidence summarized in this study can provide a standardized evidence-based basis for physical rehabilitation treatment in older patients with ICU-AW. In clinical practice, patient-specific differences and medical resource conditions should be considered, multidisciplinary collaboration should be implemented, and evidence should be reasonably translated and applied to improve patients' functional prognosis and quality of life.

【Keywords】 ICU-acquired weakness; physical rehabilitation; evidence summary; evidence-based

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Evidence Summary of Physical Rehabilitation for ICU-Acquired Weakness in Elderly Patients

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【Abstract】Objective To integrate the best evidence on physical rehabilitation for intensive care unit-acquired weakness (ICU-AW) in elderly patients using evidence-based methods, and to provide a standardized evidence-based reference for assessment and intervention.

Methods A systematic search was performed in international and domestic databases and professional websites, including ATS, RNAO, GIN, PubMed, Cochrane Library, CNKI, and Wan fang, to retrieve guidelines, expert consensuses, randomized controlled trials (RCTs), systematic reviews, meta-analyses, and evidence summaries on physical rehabilitation for elderly patients with ICU-AW. The search period covered January 2016 to January 2026. Two researchers independently conducted literature screening, quality appraisal, and data extraction, followed by cross-checking. Literature quality was evaluated using the JBI Critical Appraisal Tools and the AGREE II instrument, and the level of evidence was graded according to the JBI Evidence Grading System.

Results A total of eight publications were included: one guideline, two expert consensuses, one systematic review, one meta-analysis, one evidence summary, and two RCTs. The overall quality of evidence was high. Twenty-seven best evidence items were summarized across six dimensions: assessment, indications, contraindications, physical therapy modalities, outcome evaluation, and safety monitoring. Key interventions included early mobilization, neuromuscular electrical stimulation, resistance training, inspiratory muscle training, and traditional Chinese medicine-based physical therapies. Specific details such as initiation timing, frequency, intensity, site of application, and safety monitoring points were clearly defined.

Conclusions The 27 evidence items summarized in this study provide a standardized, evidence-based reference for physical rehabilitation in elderly ICU-AW patients. In clinical practice, patient individual differences and available healthcare resources should be taken into account, multidisciplinary collaboration is recommended, and evidence should be appropriately adapted and applied to improve functional outcomes and quality of life in these patients.

【Key words 】 ICU-acquired weakness; physical rehabilitation; evidence summary; evidence-based practice

Fund program: Medical and Health Project of Baoshan District, Shanghai (2025-E-60); Hospital Management Research Fund of Shanghai Hospital Association (X2025162); Policy Research Project of Baoshan Branch, Renji Hospital, Shanghai Jiao Tong University School of Medicine (2025-rbzy-03)

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ICU-AW is a clinical syndrome caused by critical illness and its treatment measures, mainly manifested as generalized muscle weakness and muscle atrophy, often symmetrically involving the limbs and respiratory muscles[^1,^2]. With the continuing acceleration of population aging in China, the number of older ICU patients continues to rise[^3]. Studies have shown that the incidence of ICU-AW increases significantly with age, reaching 50%-70% among ICU patients aged 65 years and older[^4]. In addition, the risk increases further in the presence of underlying diseases; this not only prolongs the duration of mechanical ventilation and length of hospitalization, but is also closely associated with long-term disability and mortality[^5]. Physical rehabilitation therapy is a core non-pharmacological approach for the prevention and treatment of ICU-AW, mainly including neuromuscular electrical stimulation (NMES), early mobilization, bedside exercise, and progressive muscle-strength training. At present, physical rehabilitation therapy has already been applied in older ICU patients and has achieved certain results in preventing ICU-AW[^6]. However, because there is considerable heterogeneity in intervention methods and therapeutic effects[^7], there remains a lack of relevant guidelines or consensus to provide clinical reference. Therefore, based on evidence-based methods, this study systematically searched relevant domestic and international literature, conducted quality appraisal and evidence extraction, and aimed to summarize the best evidence for physical rehabilitation therapy so as to provide a reference for clinical rehabilitation practice in older patients with ICU-AW.

1 Materials and Methods

1.1 Clarifying the Question

According to the PICOS principle, the evidence-based question was constructed as follows: the study population (Patient, P) was older patients with ICU-AW; the intervention (Intervention, I) was physical rehabilitation therapy; the comparison measure (Comparison, C) was conventional treatment; the outcome indicators (Outcome, O) included the incidence of ICU-AW, duration of mechanical ventilation, ICU length of stay, diaphragmatic activity, etc.; and the study types (Study, S) covered guidelines, randomized controlled trials (RCTs), systematic reviews, expert consensus, etc. This study has been registered with the Fudan University Centre for Evidence-based Nursing (registration No.: ES20269879).

1.2 Literature Search and Screening

According to the "6S" evidence model, the following sources were searched: American Thoracic Society (ATS) clinical practice guidelines, Registered Nurses' Association of Ontario (RNAO), Guidelines International Network (GIN), and Canadian Medical Association clinical practice

Guideline Library (Canadian Medical Association Clinical Practice Guideline Library, CMACPGL), BMJ Best Practice, UpToDate clinical consults, the Scottish Intercollegiate Guidelines Network (SIGN), the PubMed database of the U.S. National Library of Medicine, the Cochrane Library database, the National Guideline Clearinghouse (NGC), the Embase database, the Cumulative Index to Nursing and Allied Health Literature (CINAHL), the UM Library database, the Physiotherapy Evidence Database (PEDro), the National Institute for Health and Care Excellence (NICE) database, the New Zealand Guidelines Group (NZGG), the Chinese Medlive Guidelines website, CNKI, and Wanfang Data. The search period was from January 2016 to January 2026. Citation tracing was used for supplementation, and authors were contacted when necessary to obtain full texts. The literature languages were primarily Chinese and English. Two researchers independently screened the literature; if disagreements arose, consensus was reached through discussion within the project team or by consulting experts.

Searches were conducted using a combination of subject headings and free-text terms. Chinese search terms: ICU-acquired weakness, ICU-acquired myasthenia, critical illness polyneuropathy (CIP), critical illness myopathy (CIM), critical illness polyneuromyopathy, critical illness neuromuscular abnormalities, ICU-acquired paralysis, ICU-acquired debility, sarcopenia, sarcopenia; physical therapy, rehabilitation therapy, physiotherapy, exercise therapy, functional training, functional exercise, motor training, muscle strength training, neuromuscular rehabilitation, electrical stimulation therapy, transcutaneous electrical stimulation, neuromuscular electrical stimulation (NMES), early activity, early rehabilitation, early exercise, early mobilization, goal-directed mobilization, resistance training, resistance exercise, in-bed cycling, cycle ergometry training, occupational therapy, multimodal rehabilitation, combined intervention; geriatric ICU patients; systematic review, Meta-analysis, randomized controlled trial, guidelines, expert consensus, evidence summary. English search terms: ICU-acquired weakness, ICU-acquired myopathy, Critical illness polyneuropathy (CIP), Critical illness myopathy (CIM), Critical illness polyneuropathy and myopathy, Critical illness neuromuscular abnormalities, ICU-acquired paralysis, ICU-acquired debility, Sarcopenia;

Physical therapy, Rehabilitation therapy, Physiotherapy, Exercise therapy, Functional training, Functional exercise, Motor training, Muscle strength training, Neuromuscular rehabilitation, Electrical stimulation therapy, Transcutaneous electrical nerve stimulation (TENS), Neuromuscular electrical stimulation (NMES), Early mobilization, Early rehabilitation, Early exercise, Early activity, Goal-directed mobilization, Resistance training, Resistance exercise, In-bed cycling, Cycle ergometry training, Occupational therapy, Multimodal rehabilitation, Combined intervention; Geriatric ICU patients; Systematic review, Meta-analysis, Randomized controlled trial, Guidelines, Expert consensus, Evidence summary.

1.3 Literature Inclusion and Exclusion Criteria

Inclusion criteria: publicly published guidelines, expert consensus statements, RCTs, systematic reviews, meta-analyses, evidence summaries, etc., concerning physical rehabilitation for older patients with ICU-AW; revised or updated literature; complete information; Chinese- or English-language literature.

Exclusion criteria: full text unavailable; duplicate publications or translations; low methodological quality; incomplete information.

1.4 Literature Quality Appraisal

The JBI Evidence-Based Health Care Center appraisal tools were used to evaluate RCTs, expert consensus statements, systematic reviews, and other types of literature[^8]; for clinical guidelines, the Appraisal of Guidelines for Research and Evaluation II (AGREE II) instrument was applied[^9]. For guidelines with incomplete methodological descriptions, the JBI guideline appraisal module was additionally used. Two researchers trained in evidence-based methodology independently completed the appraisal; any disagreements were resolved through consensus meetings. In addition, two evidence-based nursing experts, one physical therapist, and one critical care medicine expert were invited to deliberate on the safety, feasibility, and other aspects of the evidence. The JBI evidence pre-grading system was adopted[^10]. According to the principles of evidence recommendation, evidence quality was classified into levels 1–5, and, in combination with the FAMA structure, a comprehensive evaluation was conducted across four dimensions: feasibility (F), appropriateness (A), meaningfulness (M), and effectiveness (E). In accordance with the principles for grading recommendation strength, evidence with grade A recommendations (strong recommendations) and grade B recommendations (weak recommendations) was included in the analysis.

2 Results

2.1 Literature Screening Process and Characteristics

The initial screening identified a total of 3,565 relevant articles. The literature screening process is shown in Figure 1. After stepwise screening, 8 articles were ultimately included[^7,11-17], including 1 guideline[^11], 2 expert consensus statements[^12,13], 1 systematic review[^14], 1 evidence summary[^15], 1 meta-analysis[^7], and 2 RCT articles[^16,17] (Figure 1). The basic characteristics are shown in Table 1.

Relevant databases (n=3565): BMJ Best Practice (n=216), UpToDate (n=130), BMJ Clinical Evidence (n=214), World Health Organization (n=188), Cochrane systematic reviews (n=1213), JBI systematic reviews (n=202), PubMed (n=1294), CINAHL (n=3), CNKI (n=79), Wanfang (n=26)
↓
Records obtained after removing duplicates (n=3287) → Excluded after reading

titles and abstracts (n=3193)
↓
Full-text rescreening (n=94) → Excluded (n=86): population inconsistent, intervention inconsistent, study type inconsistent, duplicate publication, full text unavailable, conference abstract or protocol, language inconsistent
↓
Included literature (n=8)

Figure 1. Literature screening process

Table 1. General characteristics of the included literature (n=8)

Included literature	Year of publication	Source	Type	Topic
Hodgson C L et al.[11]	2025	PubMed	Guideline	Guidelines for physical rehabilitation and activity practice in adult intensive care units in Australia
Beil M et al.[12]	2025	PubMed	Expert consensus	Recommendations for the management of older ICU patients
Liu Youshuo et al.[13]	2025	Wanfang	Expert consensus	Chinese expert consensus on the prevention and management of ICU-acquired frailty in older adults

Included literature	Year of publication	Source	Type	Topic
Welch C et al.[14]	2021	PubMed	Systematic review	Systematic review of interventions for decreased muscle mass and function in hospitalized older adults—toward the treatment of acute sarcopenia
Fuentes-Aspe R et al.[7]	2024	PubMed	Meta-analysis	Systematic review and meta-analysis of factors associated with ICU-acquired frailty
Liu Haiying et al.[15]	2024	Wanfang	Evidence summary	Best-evidence summary and evidence-based practice of exercise interventions for older patients with sarcopenia in intensive care units

Included literature	Year of publication	Source	Type	Topic
Alahmari M et al.[16]	2025	PubMed	RCT	Functional outcomes of inspiratory muscle training in older ICU-AW patients with gait impairment
Chu Lei et al.[17]	2019	CNKI	RCT	Clinical effects of early rehabilitation training for acquired muscle weakness in older ICU patients

2.2 Evidence Extraction and Integration

Two researchers trained in evidence-based methodology independently completed the process. Evidence was extracted from the included literature and cross-checked. There were initially 46 evidence items; 7 items with duplicate descriptions across different publications were removed, and 12 items with similar content were merged. After deduplication and classification, 27 items of best evidence were ultimately formed. The principles followed for merging were: items with the same topic and similar wording; when the evidence levels differed but the conclusions were consistent, the higher-level evidence was adopted; scattered parameters for the same intervention measure were uniformly incorporated into the same item.

2.3 Quality Evaluation of the Included Literature

2.3.1 Quality evaluation results for guideline literature

Quality evaluation results for guideline literature (Table 2): A total of 1 guideline article[^11] was included; the overall evidence level was relatively high, and it was included in the analysis.

2.3.2 Quality evaluation results for expert consensus

Quality evaluation results for expert consensus (Table 3): A total of 2 expert consensus articles[^12][^13] were included; the overall evidence level was relatively high, and they were included in the analysis.

2.3.3 Quality evaluation results for systematic reviews and Meta-analysis literature

Quality evaluation results for systematic reviews and Meta-analysis literature (Table 4): A total of 1 systematic review article[^14] and 1 Meta-analysis article[^7] were included; the overall evidence level was relatively high, and both were included in the analysis.

2.3.4 Quality evaluation results for RCT literature

Quality evaluation results for RCT literature (Table 5): A total of 2 RCT articles[^16][^17] were included; the overall evidence level was relatively high, and both were included in the analysis.

2.3.5 Quality evaluation results for evidence-summary literature

Quality evaluation results for evidence-summary literature: A total of 1 evidence-summary article[^15] was included. The evidence summary came from the JBI evidence database; therefore, it was directly included.

2.4 Evidence summary

Evidence summary (Table 6): A total of 27 pieces of evidence were extracted and summarized across six dimensions: assessment, adaptation, contraindications, physical therapy models, outcome evaluation, and safety monitoring.

Table 2 Methodological quality evaluation of included guidelines (n=1)

Table 2 Methodological quality evaluation included in the guidelines (n=1)

Included guideline	Domain standardized percentage (%)—Scope and purpose	Domain standardized percentage (%)—Participants	Domain standardized percentage (%)—Rigor of guideline development	Domain standardized percentage (%)—Clarity of guideline presentation	Domain standardized percentage (%)—Clarity of guideline presentation	Domain standardized percentage (%)—Editorial independence of the guideline	Number of domains >60% (n)	Number of domains >30% (n)	Recommendation grade (grade)
Hodgson C L et al.[^11]	94%	89%	86%	92%	78%	85%	6	6	A

Table 3 Methodological quality evaluation of included expert consensus (n=2)

Table 3 Methodological quality assessment of included expert consensus (n=2)

Included expert consensus							Overall evaluation
Beil M et al.[^12]	Yes	Yes	Yes	Yes	Yes	Yes	Included
Liu Youshuo et al.[^13]	Yes	Yes	Yes	Yes	Yes	Yes	Included

Note: Was the source of the viewpoint clearly indicated? Did the viewpoint come from influential experts in the field? Were the proposed viewpoints centered on the interests of the population relevant to the study? Were the stated conclusions based on the results of analysis? Was the expression of the viewpoints logical? Were other existing literatures consulted? Were there any inconsistencies between the proposed viewpoints and previous literature?

Table 4 Methodological quality evaluation of included systematic reviews and Meta-analyses (n=2)

Table 4 Methodological quality evaluation of systematic evaluation and meta-analysis (n=2)

Included systematic reviews and meta-analyses												Overall evaluation
Welch C et al.[^14]	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Included
Fuentes-Aspe R et al.[^7]	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Included

Note: Were the evidence-based questions proposed clear and explicit? Were the inclusion criteria for the literature appropriate? Was the search strategy adopted appropriate? Were the sources of the research papers appropriate? Were the criteria used for assessing literature quality appropriate? Was literature quality assessment independently completed by two or more reviewers? Were certain measures adopted during data extraction to reduce errors? Were the methods for synthesizing/combining studies appropriate? Was possible publication bias assessed? Were recommendations for policy and/or practice made with the support of reported data? Were appropriate suggestions made regarding specific directions for further research?

Table 5. Methodological quality assessment of included RCTs (n=2)

Table 5: Methodological quality assessment of included RCTs(n=2)

Included RCT														Overall assessment
Alahmari M et al.[16]	Yes	Unclear	Yes	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Included
Chu Lei et al.[17]	Yes	Unclear	Yes	No	No	Unclear	Yes	Yes	Yes	Yes	Yes	Yes	No	Included

Note: Was true randomized grouping used in the allocation of study participants? Was allocation concealment used in the grouping scheme? Were the baselines of the experimental and control groups comparable? Was blinding applied to the study participants? Was blinding applied to the interveners? Was blinding applied to the outcome assessors? Apart from the intervention to be tested, were the other measures in each group the same? Was follow-up complete; if incomplete, were measures taken to address it? Were all enrolled study participants included in the outcome analysis? Were the outcome indicators of study participants in each group assessed in the same manner? Were the methods for assessing the outcome indicators reliable? Was the data-analysis method appropriate? Was the study design reasonable? During study implementation and analysis, were there deviations beyond the standards of an RCT?

Table 6. Evidence summary for physical rehabilitation therapy in older patients with ICU-acquired weakness

Item	Evidence summary	Evidence level (grade)	Recommendation grade (grade)
Assessment	1. Diagnosis: The MRC total score is most commonly used; a score of <48 can diagnose ICU-AW, and a score of <36 can diagnose severe ICU-AW[13,16].	1	A
Assessment	2. Assessment of functional activity capacity: The Timed Up and Go Test (TUGT), Short Physical Performance Battery (SPPB), gait-speed test, 6-minute walk test (6MWT), 10-meter walk test (10mWT), and maximum walking distance are used to assess mobility function[13,14,16];	1	A

Item	Evidence summary	Evidence level (grade)	Recommendation grade (grade)
Assessment	3. Assessment of activities of daily living: The Barthel Index, functional independence score (Katz/FIM), ICU Mobility Scale, and health-related quality-of-life questionnaire (SF-36)—including total physical health score and total mental health score—are used, combined with the Acute Physiology and Chronic Health Evaluation II (APACHE II) and body mass index for comprehensive assessment[13,14,16].	1	A

Item	Evidence summary	Evidence level (grade)	Recommendation grade (grade)
Assessment	4. Handgrip strength (HGS): Measured with a hand dynamometer. The patient assumes a semi-sitting position with the elbow flexed at 90°; each hand is measured twice and the average is taken. Men with <28 kg and women with <18 kg can be diagnosed with reduced muscle strength[15].	1	B
Assessment	5. Muscle mass assessment: Ultrasound is used to measure quadriceps muscle-layer thickness and cross-sectional area, and dual-energy X-ray absorptiometry is used[13,15].	1	A

Item	Evidence summary	Evidence level (grade)	Recommendation grade (grade)
Assessment	6. Electrophysiology and pathology: Electromyography/nerve conduction studies are used to diagnose critical illness polyneuropathy, myopathy, or neuromyopathy[13,16].	1	A
Assessment	7. Respiratory muscle function: For mechanically ventilated patients, diaphragmatic ultrasound, transdiaphragmatic pressure, maximal inspiratory pressure, and maximal expiratory pressure are recommended.	1	A

	assessment, which helps with diagnosis and prognosis prediction (e.g., weaning success rate)[13,16].		

	8. Timing of assessment: It is recommended to initiate early mobilization rehabilitation assessment within 24–48 h after ICU admission, begin intervention as early as conditions permit, and conduct dynamic assessments during hospitalization (e.g., every 7–10 days)[11,13,17].	1	A

	9. Nonmodifiable risk factors: advanced age, female sex, systemic inflammatory response, sepsis, and multiple organ dysfunction/failure;modifiable risk factors: prolonged immobilization, mechanical ventilation, parenteral nutrition, renal replacement therapy, poor glycemic control, and disturbance of the internal environment[7,13].APACHE II $\geq$ 15 points and an elevated SOFA score may help provide early warning.	1	A

	10. Medication risks: neuromuscular blockers, glucocorticoids, norepinephrine, aminoglycosides, etc. Patients receiving these drugs should be assessed and preventive measures should be taken[13].	2	B
Indications	11. Patients receiving invasive mechanical ventilation may undergo physical rehabilitation[11].	1	B

Indications	12. Neuromuscular electrical stimulation (NMES) is recommended to assist critically ill patients who cannot actively participate in exercise, especially patients with prolonged bed rest and longer ICU stays[13].	1	A
Indications	13. Exercise therapy is applicable to patients who can cooperate with active or passive activities, especially ICU patients who are able to undergo early rehabilitation[16].	1	B

Contraindications	14. Neurological, spinal, or musculoskeletal dysfunction, or major trauma that may limit activity, such as fracture or after joint replacement surgery[16].	2	B
Contraindications	15. Inability to cooperate with comprehensive whole-body functional assessment and rehabilitation training[17].	2	B

Physical therapy model	16. Exercise therapy: After sedation and analgesia targets are achieved, progressive bedside rehabilitation training should be initiated as early as possible (physical therapy and occupational therapy, progressive resistance training, goal-directed activities, etc.); daily implementation is recommended[13-17].Exercise sequence (four-level sequential program): Level 1 (passive activity): For patients with Richmond Agitation-Sedation Scale (RASS) scores of −3 to −4 or who cannot actively cooperate, passive joint activities are performed twice daily, 15–30 min each time. Level 2 (active-assisted/active	1	A

Physical therapy model	17. Resistance training: Use sandbags as the load, with intensity at 50% of the maximum load; each movement is performed in 3 sets, 10 repetitions per set, with 1–2 min of rest between sets. Upper limbs: bilateral shoulder flexion and abduction, elbow flexion and extension, and wrist flexion and extension; lower limbs: bilateral hip flexion and abduction, knee flexion and extension, and ankle dorsiflexion.	1	B

Physical therapy model	18. Inspiratory muscle training (IMT): Use a threshold loading trainer (Philips Respironics threshold), with intensity set at 40% of baseline MIP. Each training session includes 3 sets, 10 breaths per set, with 1 min of rest between sets; twice daily, 5 days per week, for 4 weeks[16].	1	A

Physical therapy model	19. NMES: 1–2 times daily, 30–60 min each time, applied to the major muscle groups of the limbs, such as the quadriceps femoris, gastrocnemius, tibialis anterior, biceps brachii, and triceps brachii. It is recommended to begin within 24–48 h after ICU admission and continue until transfer out of the ICU[16].	1	B

Physical therapy model	20. On the basis of comprehensive treatment, traditional Chinese medicine syndrome-differentiated treatment and physiotherapy may be performed, such as Buzhong Yiqi Decoction, acupuncture, acupoint electrical stimulation, and mild moxibustion[13].	2	C

Effect evaluation	21. Indicators for evaluating therapeutic efficacy include[16]:Lower-limb muscle strength: significant improvement in MRC score and maximal muscle strength testing.Walking ability: significant improvement in Functional Ambulation Category (FAC), 10-meter walk test, TUGT, and 6-minute walk test.Cardiopulmonary endurance: maximal inspiratory pressure (MIP), maximal expiratory pressure (MEP), forced vital capacity (FVC), and forced expiratory volume in 1 second (FEV1).Functional and prognostic indicators: significant improvement in activities of daily living score, quality-of-life score, and APACHE score.	1	A

Effect evaluation	22. Main benefits: reducing ICU-AW risk: functional/multimodal rehabilitation can reduce the incidence of ICUAW; improving clinical outcomes: it can shorten the duration of mechanical ventilation, ICU stay, and hospital stay, and may improve long-term patient-reported physical function, such as at 6 months; reducing delirium: early mobilization can reduce the incidence and duration of delirium; improving long-term cognition: it can improve long-term functional prognosis	1	A

Category	No.	Content	Score	Grade
[[unclear: continuation from previous page]]		[17].		

Category	No.	Content	Score	Grade
Safety monitoring	23.	Criteria for initiating exercise rehabilitation: cardiovascular system (systolic blood pressure 90–180 mmHg, mean arterial pressure 60–110 mmHg, heart rate 40–130 beats/min, no newly developed malignant arrhythmia, and vasoactive drug dosage stable or decreasing); respiratory system (fraction of inspired oxygen ≤ 0.6, oxygen saturation $\geq 90\%$, respiratory rate ≤ 45 breaths/min, no respiratory distress, and no patient-ventilator dyssynchrony); nervous	5	A

Category	No.	Content	Score	Grade
Safety monitoring	24.	Monitoring during exercise: monitor vital signs in real time, the Critical-Care Pain Observation Tool (CPOT), Borg scale, tolerance, changes in muscle strength, and functional status; pay attention to preventing excessive fatigue and safety issues [11, 13, 15];	5	A

Category	No.	Content	Score	Grade
Safety monitoring	25.	Criteria for suspension: heart rate/blood pressure outside the normal range, oxygen saturation < 88%, newly developed arrhythmia, patient–ventilator dyssynchrony, irritability, falls, unplanned extubation, catheter dislodgement, etc. [11, 13, 15].	5	A

Category	No.	Content	Score	Grade
Safety monitoring	26.	When using NMES, the stimulation intensity should be based on producing visible muscle contraction and being tolerable to the patient; if in doubt, confirm muscle contraction by local palpation [16].	1	B

Category	No.	Content	Score	Grade
Safety monitoring	27.	Blood glucose management targets: maintain 6.1–7.8 mmol/L in patients without a history of diabetes; maintain 6.1–11.1 mmol/L in patients with a history of diabetes; use insulin pumps, dynamic blood-glucose monitoring, and individualized glycemic-control strategies [7, 13].	1	A

3. Discussion

3.1 Current status of ICU-AW in older adults

ICU-AW in critically ill older patients is characterized by a high incidence, great harm, and insidious onset. Studies have shown that the overall incidence of ICU-AW is approximately 48% [18], and that the incidence among patients receiving mechanical ventilation for more than 7 days can be as high as over 60% [19]. Owing to physiological characteristics such as age-related muscle loss, a heavy burden of underlying diseases, and decreased metabolic reserve, older patients constitute the population at highest risk for ICU-AW [7].

ICU-AW has both short-term and long-term serious effects on older patients.

Short-term harms usually manifest as prolonged mechanical ventilation, difficulty in weaning, and increased ICU and total hospital length of stay; the long-term harms are even more profound: approximately 35% of patients still have frailty symptoms one year after ICU discharge, and 24%–50% have residual muscle weakness, with persistent impairment of physical function and quality of life [19, 20]. A 6-month post-discharge follow-up of ICU-AW patients by Sidras et al. [20] showed that patients not only had persistently reduced muscle-strength indicators, but also had functional independence (FIM score) and quality of life (SF-36/NHP score) significantly lower than those of non-ICU-AW patients. This indicates that the harm of ICU-AW may evolve into chronic functional impairment after transfer out of the ICU and become a core component of post-intensive care syndrome. Therefore, systematically summarizing and promoting effective evidence for physical rehabilitation is of great significance for improving the short-term and long-term prognosis of older ICU-AW patients.

3.2 Early assessment of ICU-AW in older adults

Evidence 1–10 covers a multidimensional assessment ranging from basic diagnosis to functional status, and from muscle-strength measurement to respiratory function. In terms of diagnosis, an MRC total score < 48 as the diagnostic criterion for ICU-AW has gained broad international consensus [13, 19]; it is easy to perform and suitable for rapid bedside assessment. In terms of functional assessment, tools such as TUGT, SPPB, and 6MWT can dynamically monitor changes in the functional status of older patients and provide a basis for evaluating rehabilitation effects. Ultrasound can assess dynamic changes in muscle mass [13, 15]; by monitoring early changes in quadriceps thickness and cross-sectional area, it can predict the occurrence of ICU-AW [18]. It is noninvasive and feasible at the bedside, and therefore has broad application prospects. Respiratory

Regarding inspiratory muscle function assessment, performing diaphragm ultrasound and assessments such as maximal inspiratory pressure in mechanically ventilated patients can predict weaning success[13, 16]. Respiratory muscle weakness is usually the main cause of difficult weaning; incorporating respiratory muscle assessment into routine monitoring can provide a reference for early identification of weaning risk.

Multiple studies recommend that assessment should be initiated within 24–48 h after ICU admission and dynamically monitored during hospitalization[11, 13, 17]. Fazzini et al.' s[18] meta-analysis showed that critically ill patients lose nearly 2% of skeletal muscle each day during the first week after ICU admission. Hodgson H et al.[21] considered that, under immobilized conditions, the rate of muscle atrophy in older adults does not differ significantly from that in younger individuals; however, their baseline muscle mass is lower, anabolic resistance is more prominent, and recovery capacity is poorer. The functional damage caused by the same proportional loss of muscle is therefore more severe, and recovery time is longer. Thus, the time window for early assessment is more urgent. ICU-AW screening and intervention should be carried out as early as possible, and the baseline status of muscle function should be clarified to lay a foundation for subsequent dynamic assessment.

3.3 Indications and contraindications for ICU-AW in older adults

Clarifying the indications and contraindications for physical rehabilitation is a prerequisite for ensuring rehabilitation efficacy and safety. In terms of indications, Evidence 11–13[11, 13, 16] indicates that older patients with basic ability to cooperate should receive early rehabilitation, even when severe functional impairment is present; they may still benefit from inspiratory muscle training and resistance training. For critically ill older patients who are unable to exercise actively, NMES is recommended to assist rehabilitation. Through low-frequency electrical stimulation, NMES induces passive muscle contraction, which can effectively counteract disuse muscle atrophy. It is particularly suitable for those who are sedated or hemodynamically unstable. Studies show that early NMES intervention can significantly improve muscle strength and shorten the duration of mechanical ventilation[22]. In addition, patients receiving invasive mechanical ventilation should also be included in the rehabilitation scope. Mechanical ventilation is an independent risk factor for ICU-AW; such patients should start rehabilitation as early as possible after hemodynamic stabilization to counteract disuse atrophy of the respiratory muscles and limb muscles[23].

In terms of contraindications, for patients with neurological or musculoskeletal dysfunctions (such as active fractures or acute spinal cord injury) and those unable to cooperate with assessment and training, rehabilitation activities should be carried out cautiously[16, 17]. For patients who cannot cooperate because of excessive sedation or delirium, the influencing factors should be addressed first, and reassessment should be performed after the condition improves. Strict adherence to safety screening criteria can significantly reduce the incidence of rehabilitation-related adverse events[11, 13]. It should be noted that vertebral compression fractures, severe osteoporosis, and degenerative osteoarthropathy have a significantly increased prevalence among older adults[24], making the above contraindications more common in this population. In clinical decision-making, the appropriateness of rehabilitation should be dynamically evaluated through multidisciplinary team collaboration; when some contraindicating factors are present, lower-intensity interventions such as passive activities may be selected rather than completely abandoning rehabilitation[25].

3.4 Physical therapy strategies for ICU-AW in older adults

At present, there are still no specific interventions for ICU-AW; early prevention and intervention are the core strategies. The physical therapy strategies integrated in this study cover early mobilization, NMES, resistance training, inspiratory muscle training, and traditional Chinese medical therapy, reflecting the principles of multimodal integration and individualized implementation.

Exercise rehabilitation emphasizes early initiation and progressive loading. Evidence 16[13-17] recommends that, after the targets for sedation and analgesia are achieved, a four-level sequential protocol should be followed

(passive activity → active activity → sitting up → resistance training → standing/walking) should be initiated as early as possible, all under the guidance of professional medical staff, with close monitoring of vital signs. Multiple meta-analyses have confirmed that early mobilization can significantly reduce the incidence of ICU-AW, shorten the duration of mechanical ventilation and hospitalization, and improve patients' functional outcomes[6,26]. Initiation within 24–72 h after ICU admission yields the best effect and is consistent with the recommendations of the German critical care guidelines[27]. For older populations, the progressive design of this protocol has significant clinical value. Baroreflex sensitivity declines with aging, and the ability to regulate blood pressure during postural changes weakens; this process places particular demands on cardiovascular compensatory reserve[28]. Stepwise transitions can effectively reduce the risks of orthostatic hypotension and falls.

Resistance training is the core approach for improving limb muscle strength. Evidence 17[16] recommends a load of 50% 1RM, 3 sets × 10 repetitions, with 1–2 min of rest between sets; the training movements cover the major muscle groups of the limbs, including the shoulder, elbow, wrist, hip, knee, and ankle. A moderate intensity of 50% 1RM can effectively activate type II muscle fibers, whose atrophy is a key mechanism underlying the decline in muscle strength in ICU-AW[14]. At the functional level, upper-limb training maintains the ability to perform activities of daily living, lower-limb training improves standing and walking function, and ankle dorsiflexion training prevents foot drop[15]. However, very old and frail patients may be unable to tolerate the initial load because of limited cardiovascular reserve. During rehabilitation, the Borg rating of perceived exertion may be used as an individualized auxiliary adjustment indicator, starting at a lower intensity and increasing gradually as muscle strength recovers. Inspiratory muscle training (IMT) targets respiratory muscle function and helps improve weaning prognosis. Evidence 18[16] recommends using a threshold loading trainer at an intensity of 40% of baseline MIP, 3 sets × 10 breaths, with 1 min of rest between sets, twice daily, 5 days per week, for 4 weeks. An intensity of 40% MIP can effectively stimulate recruitment of diaphragmatic motor units while avoiding the risk of respiratory distress[22]. For older patients with comorbid chronic obstructive pulmonary disease or reduced left ventricular ejection fraction, the initial training intensity may be lowered to 30% MIP[29]. During training, bedside monitoring of respiratory rate and the use of accessory respiratory muscles should be strengthened to avoid respiratory muscle fatigue induced by excessive ventilatory load.

NMES is suitable for patients who are unable to exercise actively, and its effectiveness has been verified in multiple studies. Evidence 19[16] recommends 1–2 sessions per day, 30–60 min per session, applied to the major muscle groups of the limbs; large muscle groups such as the quadriceps femoris and gastrocnemius are the core target muscles for intervention. It should be initiated within 24–48 h after ICU admission and continued until transfer out of the ICU. The latest meta-analysis[30] confirmed that NMES can reduce the incidence of ICU-AW, delay loss of muscle mass, and enhance muscle strength. Its subgroup analysis also supports the effectiveness of stimulation duration; however, its effects on clinical outcomes such as duration of mechanical ventilation, ICU length of stay, and mortality remain unclear, possibly related to heterogeneity in stimulation protocols. Optimization of stimulation parameters remains a current research focus. Early studies have indicated[31] that excessively high stimulation frequencies (50 Hz) can readily induce muscle fatigue and instead reduce efficacy. In the future, large-sample RCTs are still needed to determine the optimal treatment parameters and outcome indicators, with dynamic adjustment according to patient tolerance and individualization.

In addition, traditional Chinese medicine syndrome-based treatment and physical therapies (such as Buzhong Yiqi Decoction, acupuncture, and acupoint electrical stimulation), as adjunctive approaches, have shown potential in the rehabilitation of older patients with ICU-AW[13]. Their concepts of "holistic regulation" and "syndrome-based treatment" are consistent with multimodal rehabilitation strategies and warrant further exploration.

3.5 Evaluation of the Effects and Safety Monitoring of ICU-AW in Older Adults

Scientific evaluation of effectiveness is key to measuring the efficacy of rehabilitation. Evidence 21[16] evaluates outcomes from four aspects: lower-limb muscle strength, walking ability, cardiopulmonary endurance, and function and prognosis. Muscle-strength indicators (MRC score and maximum muscle-strength testing) are the gold standard for the diagnosis of ICU-AW and for judging therapeutic efficacy[19]; improvement in walking-ability indicators is closely related to patients' quality of life after discharge[20]; cardiopulmonary endurance indicators (MIP, MEP, FVC, FEV1) are directly associated with the success rate of ventilator weaning[22]; and functional and prognostic indicators (activities of daily living, quality of life, and APACHE score) reflect the impact of rehabilitation on the patient's overall condition. Meta-analysis shows that early mobilization, NMES, and their combined application can all reduce the incidence of ICU-AW, with the combined application producing a more significant therapeutic effect[32]. Sunaryo et al.[33] confirmed that early rehabilitation can reduce the risk of ICU-AW by 10%, with the optimal effect achieved when initiated within 1–3 days after ICU admission. Evidence 22[17] summarizes the main benefits—reducing the risk of ICU-AW, improving clinical outcomes, reducing delirium, and improving long-term cognition—all of which are supported by evidence-based findings. Recent research suggests that cognitive functional status at the time of transfer out of the ICU is an independent predictor of recovery in activities of daily living after discharge[34], indicating that rehabilitation programs should incorporate cognitive function assessment and training on the basis of exercise training. In addition, functional recovery is slow in older patients, and the time points for evaluating effectiveness should be appropriately extended so as to comprehensively assess the long-term effects of rehabilitation interventions.

While attention is paid to rehabilitation efficacy, safety monitoring must not be neglected. Evidence 23-25[7, 11, 13, 15, 16] integrates safety monitoring throughout the entire rehabilitation process and specifies three key steps: assessment before initiation, monitoring during exercise, and termination criteria. Initiation criteria (cardiovascular, respiratory, and neurological indicators) are the core basis for determining whether patients can tolerate rehabilitation, and strict adherence to these criteria can significantly reduce the incidence of rehabilitation-related adverse events[20]. During exercise, vital signs and functional status should be dynamically monitored; once abnormalities in heart rate/blood pressure/oxygen saturation, new-onset arrhythmias, falls, or other indications occur, the intervention should be terminated immediately. Evidence 24[16] emphasizes that the stimulation intensity of NMES should be sufficient to induce visible muscle contraction and remain tolerable to the patient, avoiding excessively strong stimulation that may cause skin injury or muscle fatigue. Meta-analysis has also confirmed that NMES can shorten the duration of mechanical ventilation and has a low incidence of adverse events[35]. Evidence 25[7, 13] recommends that glycemic-management targets reflect the integration of metabolic support and rehabilitation; hyperglycemia can impair neuromuscular function through oxidative stress[20], and incorporating it into safety monitoring can help improve the overall rehabilitation effect.

In addition, the application of the above safety thresholds in older patients still requires appropriate adjustment with reference to the individual baseline level. Existing guidelines indicate[36] that even if the preset termination threshold has not been reached, if significant fluctuations in heart rate or blood pressure are detected during rehabilitation, the intervention should be suspended and the patient reassessed. Because older patients have limited physiological reserve and delayed compensatory responses, subtle hemodynamic changes may signal potential risks. At the same time, the prevalence of multimorbidity and polypharmacy in this population further increases the complexity of rehabilitation safety assessment. Therefore, rehabilitation and safety monitoring for older patients with ICU-AW should not mechanically apply fixed thresholds; rather, individual baseline levels, medication use, and comorbid conditions should be incorporated into comprehensive analysis, and a patient-centered dynamic assessment strategy should be implemented.

3.6 Limitations

This study has certain limitations. At present, high-quality research specifically targeting older populations with ICU-AW remains insufficient, and some evidence is derived from studies on sarcopenia in older adults and rehabilitation in adult ICU patients; the extrapolation of such evidence to older populations requires cautious consideration. Therefore, when translating these findings into clinical application, clinicians are advised to integrate individual patient differences with multidisciplinary team assessment. Future research urgently needs to conduct more studies focused on older

large-sample, multicenter studies in the ICU-AW population, so as to further verify the best-practice protocols for physical rehabilitation.

4. Summary

Through systematic retrieval and screening, this study included a total of 8 high-quality publications. From six dimensions—assessment, indications, contraindications, physical-therapy modalities, outcome evaluation, and safety monitoring—it summarized and developed 27 items of best evidence for physical rehabilitation targeting elderly patients with ICU-AW. The evidence system covers core intervention approaches such as early mobilization, neuromuscular electrical stimulation, resistance training, inspiratory muscle training, and traditional Chinese medicine physiotherapy; it clarifies key intervention parameters (such as initiation timing, frequency, intensity, and site) and implementation points, thereby providing evidence-based support for standardized physical rehabilitation in elderly patients with ICU-AW.

Existing evidence indicates that physical rehabilitation strategies characterized by early initiation, stepwise progression, multimodal integration, and individualized implementation can effectively improve muscle strength, functional status, and clinical outcomes in elderly patients with ICU-AW. However, some evidence—such as the optimal parameters for NMES and long-term follow-up data—remains heterogeneous. Moreover, most studies originate from outside China, and their recommended protocols still require localized validation and clinical translation in combination with the physiological characteristics, comorbidities, and medical environment of elderly patients in China. Future research should be based on China' s disease spectrum, medical resources, and cultural context; conduct large-sample, multicenter studies; and explore localized rehabilitation models, thereby further improving the long-term functional prognosis and quality of survival of elderly patients with ICU-AW.

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Note: Figure translations are in progress. See original paper for figures.