International Journal on Science and Technology (IJSAT)

E-ISSN: 2229-7677 ● Website: www.ijsat.org ● Email: editor@ijsat.org

Rehabilitation after Intensive Care Unit Acquired Weakness: Early Mobilization, Exercise Progression and Functional Recovery - A Narrative Review

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Abstract:

Background: Intensive care unit–acquired weakness (ICU-AW) is a diffuse neuromuscular complication of critical illness associated with impaired mobility, delayed recovery and long-term disability. Early rehabilitation has become a major strategy for countering immobility, but intervention timing, dose and progression remain variable. Objective: To synthesize evidence published from 2012 through 2020 on physiotherapy assessment, early mobilization and exercise progression for adults with ICU-AW. Methods: A structured narrative review was conducted using peer-reviewed English-language literature published between January 2012 and December 2020. Priority was given to clinical studies, systematic reviews and consensus recommendations addressing ICU-AW, muscle wasting, mobilization safety, functional outcomes and post-ICU recovery. Results: Critical illness produces rapid muscle loss through inflammation, catabolism, disuse and impaired neuromuscular function. Early mobilization is generally feasible when delivered through interdisciplinary screening and may improve strength and mobility, although effects on mortality and long-term function are inconsistent. Reliable assessment combines arousal, Medical Research Council sum score, ICU Mobility Scale and task-based measures. Rehabilitation should progress from positioning and active participation to sitting, standing, transfers, walking and endurance training, with explicit physiological safety criteria. Conclusion: Physiotherapists play a central role in identifying ICU-AW, preventing avoidable immobility and coordinating recovery across ICU, ward and community settings. Standardized dosing and longer-term outcome studies remain priorities.

Keywords: intensive care unit–acquired weakness; early mobilization; physiotherapy; mechanical ventilation; critical illness; functional recovery

Introduction

Survival after critical illness has improved, but many patients leave intensive care with profound weakness and limited independence. Intensive care unit–acquired weakness (ICU-AW) describes clinically detected diffuse, symmetrical weakness arising during critical illness without another plausible cause. It includes overlapping manifestations of critical illness polyneuropathy, critical illness myopathy and combined neuromyopathy. The condition can delay ventilator liberation, restrict mobility and contribute to post-intensive-care syndrome.

The problem develops rapidly. Prospective investigation has shown substantial skeletal-muscle loss during the first week of critical illness, particularly in patients with multiorgan failure (Puthucheary et al., 2013). Sedation, mechanical ventilation, inflammation, sepsis, hyperglycaemia, corticosteroid or neuromuscular-blocking exposure, inadequate nutrition and bed rest may interact. Weakness is therefore not simply deconditioning after discharge; it begins during acute care.

Physiotherapists increasingly intervene while patients are receiving organ support. Activities range from positioning and active-assisted exercise to sitting, standing, transferring and walking with ventilatory equipment. Early mobilization is a process, not a single manoeuvre. It requires arousal assessment, physiological stability, coordination of lines and tubes, adequate staffing and progression toward meaningful activity (Hashem et al., 2016; Hodgson et al., 2014).

Evidence published between 2012 and 2020 supports feasibility and suggests benefits for mobility and strength, but findings vary. Meta-analyses have reported reductions in ICU-AW or improvements in functional capacity, while effects on mortality and long-term outcomes are less certain (Tipping et al., 2017; Zhang et al., 2019; Zang et al., 2020). This review examines ICU-AW mechanisms, assessment, early mobilization, exercise progression, safety and continuity after ICU discharge.

Review Aim and Approach

The aim is to translate evidence on ICU-AW into a physiotherapy rehabilitation framework. Questions include how weakness develops, when assessment is valid, which patients can mobilize, how exercise should progress and what outcomes should be followed beyond ICU discharge.

The evidence period was restricted to January 2012 through December 2020. Peer-reviewed English-language trials, cohorts, systematic reviews, clinical reviews and consensus statements were prioritized when they addressed adult ICU-AW, muscle wasting, early mobility, rehabilitation safety or functional recovery. Earlier landmark trials were not included as references because of the specified date restriction, although later reviews that contextualized them were eligible.

A narrative method was selected because populations, interventions and outcomes are heterogeneous. No new participant data were collected and no meta-analysis was performed. Evidence was interpreted conservatively: feasibility did not establish efficacy, improved ICU Mobility Scale scores did not automatically imply long-term independence, and association did not establish causation.

Mechanisms and Clinical Consequences

Critical illness shifts the balance between muscle protein synthesis and breakdown. Systemic inflammation, endocrine disturbance, mitochondrial dysfunction, microvascular changes and immobility accelerate catabolism. Reduced mechanical loading causes loss of muscle cross-sectional area and force. Peripheral nerve and muscle membrane dysfunction may add electrophysiological impairment. The clinical phenotype can therefore combine structural muscle loss, impaired activation, neuropathy and poor endurance.

Mechanical ventilation contributes indirectly through sedation, delirium, bed rest and the complexity of mobilization. Diaphragm weakness may coexist with limb weakness, affecting ventilator weaning and activity tolerance. Sepsis and multiple-organ failure increase risk. Pre-existing frailty, malnutrition and neurological or musculoskeletal disease shape the magnitude of disability and should not be mislabelled as entirely ICU acquired.

ICU-AW is typically symmetrical and affects limb and respiratory muscles. Patients may be unable to lift limbs against gravity, sit unsupported or stand. Hand weakness can restrict use of walking aids. Even after apparent strength improves, reduced aerobic capacity, balance and confidence may constrain participation. Cognitive impairment, anxiety and post-traumatic stress frequently coexist as elements of post-intensive-care syndrome.

In the TEAM prospective cohort, mobilization during invasive ventilation was uncommon, and more than half of survivors assessed at ICU discharge had ICU-AW; weakness was associated with subsequent mortality (Hodgson et al., 2015). These findings demonstrate both the burden and the gap between theoretical eligibility and actual mobilization.

Long-term consequences include difficulty walking, stair climbing, self-care, work and community participation. Recovery is heterogeneous. Some patients improve rapidly after acute illness resolves; others have persistent limitations for months. Physiotherapy goals should therefore extend beyond achieving a first stand or ICU discharge.

Assessment and Diagnosis

Assessment begins with exclusion of alternative explanations. New focal weakness, asymmetry, sensory level, cranial nerve signs or evolving neurological findings require medical investigation. Pre-existing neuropathy, stroke, spinal disease, fractures and medication effects should be considered. ICU-AW is a clinical diagnosis made in the context of critical illness, supported by strength testing when cooperation is sufficient.

The Medical Research Council sum score grades six bilateral muscle groups and is commonly used, with a score below 48 traditionally supporting ICU-AW. Valid testing requires alertness, comprehension and consistent effort. Delirium, sedation, pain and language barriers can invalidate the result. A low score should not be treated as precise when participation is unreliable.

The ICU Mobility Scale records the highest level of mobility from no activity to independent walking. It is practical for daily tracking and communicates change across teams. It does not replace impairment assessment but captures clinically meaningful progression. Functional Status Score for the ICU and Chelsea Critical Care Physical Assessment Tool offer broader task-based approaches. Selection should match local training and purpose.

Physiotherapy examination includes arousal, command following, respiratory pattern, cough, joint range, oedema, skin risk, strength, balance and prior function. Functional observation may begin with head and trunk control, rolling and active limb movement. Cardiovascular and respiratory response to position change should be documented.

Baseline history from family or records is essential because pre-ICU independence influences goals. A patient previously dependent for transfers should not be judged by the same discharge target as an independent worker. Frailty measures and comorbidity add context. Nutrition, cognition and psychological symptoms require interdisciplinary assessment.

Reassessment should use consistent measures and distinguish capacity from performance. A patient may have strength to stand but not do so routinely because of lines, staffing or fear. Documentation should record assistance, devices, symptoms and physiological response, not only the activity label.

Readiness and Safety for Mobilization

Mobilization safety is based on the whole clinical picture. Consensus recommendations organize considerations into respiratory, cardiovascular, neurological and other domains (Hodgson et al., 2014). Oxygenation, ventilatory support, respiratory distress, blood pressure, heart rhythm, vasopressor stability, arousal, agitation and intracranial issues all influence decisions. Thresholds guide rather than replace clinical judgment.

Before each session the team should confirm goals, airway security, line management and staffing. Endotracheal tubes, arterial lines, dialysis catheters and extracorporeal devices are not automatic exclusions, but they increase planning requirements. The physiotherapist should know emergency procedures and stop criteria. Tubes should be organized with clear responsibility during transfers.

Potential adverse responses include desaturation, marked blood-pressure change, arrhythmia, distress, device dislodgement and falls. A systematic review found that mobilization and rehabilitation in ICU are generally safe, with low rates of potential safety events when screened appropriately (Nydahl et al., 2017). Safety depends on trained teams and cannot be generalized to unsupervised activity.

Pain, fatigue and patient preference matter. Mobilization performed through fear or uncontrolled pain can worsen trust and delirium. Communication, explanation and pacing improve participation. Sedation strategy and delirium prevention are system-level enablers because deep sedation reduces active engagement.

Stopping a session is not failure. The response provides information for the next attempt and may reveal a need for medical adjustment. Documentation should record why progression stopped, recovery time and the revised plan.

Early Mobilization and Exercise Progression

Early mobilization begins when clinically appropriate, not at an identical hour for every patient. It aims to minimize avoidable inactivity and increase active participation. A staged model helps teams progress without turning mobility into a checklist detached from patient response.

The first stage includes positioning, pressure management, range of motion and facilitation of active movement. Passive movement may preserve joint mobility but is unlikely to prevent muscle loss by itself. Active-assisted and active exercise should be introduced as arousal and motor control permit. Short, frequent sessions may be better tolerated than one prolonged session.

The next stage develops antigravity control through supported sitting, bed mobility and edge-of-bed balance. Trunk control is a critical bridge to transfer training. The clinician monitors symptoms and reduces assistance gradually. Reaching, weight shifting and lower-limb loading can prepare for standing.

Standing and transfers add greater cardiovascular and muscular demand. Tilt tables or standing devices may support selected patients, but equipment should facilitate active participation rather than substitute for it. Sit-to-stand practice can be graded by bed height, upper-limb support and assistance.

Walking may occur during mechanical ventilation when the patient is stable and the team is trained. Portable ventilation, coordinated tubing and adequate staff are required. Distance is less important initially than safe stepping and physiological tolerance. Progression can involve duration, distance, reduced assistance and more functional environments.

Exercise dose should include frequency, intensity, duration and type. ICU prescriptions are often incompletely reported, limiting replication. Perceived exertion, symptom response and workload can guide training in cooperative patients. Resistance may begin with gravity, manual resistance or bands and progress as strength returns.

Goal-directed protocols can improve mobility delivery. In a randomized surgical ICU study, early goal-directed mobilization improved mobility and shortened surgical ICU length of stay (Schaller et al., 2016). However, protocol targets must remain individualized; the highest possible level is not always the safest or most meaningful level on a given day.

Evidence for Effectiveness

The evidence base includes trials, cohorts and meta-analyses with variation in population, timing and usual care. Tipping et al. (2017) concluded that active mobilization and rehabilitation may improve mobility and muscle strength, without demonstrating an effect on mortality. This distinction is clinically important because rehabilitation primarily targets function.

Meta-analysis by Zhang et al. (2019) suggested that early mobilization may decrease ICU-AW incidence, improve functional capacity and increase ventilator-free days. Zang et al. (2020) similarly reported favourable effects on ICU-AW and length of stay. Results should be interpreted with awareness of heterogeneous definitions and intervention doses.

Observational evidence shows that actual mobilization during mechanical ventilation can remain low despite physiotherapy availability (Hodgson et al., 2015). Barriers include sedation, physiological instability, procedures, staffing and culture. Efficacy cannot improve outcomes if implementation is absent.

Some trials of intensive rehabilitation have not shown clear long-term benefit. Possible explanations include late initiation, insufficient contrast from usual care, heterogeneous risk, low dose or outcomes insensitive to change. Critical illness may also impose biological injury that exercise cannot fully prevent. Negative findings should refine rather than eliminate rehabilitation.

Evidence supports a balanced conclusion: early rehabilitation is feasible for selected patients, can improve delivered mobility and may improve strength or functional status. Effects on mortality, hospital length of stay and long-term independence are inconsistent. The intervention should be justified by functional goals and avoidance of unnecessary immobility, not overpromised as a cure for ICU-AW.

Adjunctive Interventions

Neuromuscular electrical stimulation has been proposed for patients unable to exercise actively. Evidence through 2020 was mixed, with variability in electrode placement, dose, muscle response and patient selection. It may supplement but should not replace active rehabilitation when participation is possible. Retracted evidence must not be used to support efficacy.

Cycle ergometry can provide passive, active-assisted or active leg movement in bed. It offers measurable work and may help deliver exercise before walking is possible. Clinical benefit depends on active contribution and dose. Equipment cost and staffing affect implementation.

Inspiratory muscle training may be considered after assessment of respiratory muscle weakness and ability to participate. It should be coordinated with ventilator weaning and secretion management. Routine application without a clear deficit or progression plan is not justified.

Positioning, airway clearance and breathing strategies remain important for respiratory problems but are not interchangeable with mobility. A patient may need secretion management before mobilization, while upright activity can itself support ventilation. The physiotherapist integrates respiratory and physical goals.

Nutrition supports muscle protein synthesis but critical illness metabolism is complex. Physiotherapists should coordinate exercise timing and tolerance with nutrition and medical teams. No exercise device can compensate for unresolved shock, severe inflammation or inadequate substrate.

Barriers and Implementation

Barriers operate at patient, clinician and system levels. Patient barriers include sedation, delirium, weakness, pain and instability. Clinician barriers include uncertainty, competing tasks and inconsistent expectations. System barriers include staffing, equipment, space, scheduling and a culture that prioritizes bed rest.

Implementation requires an interdisciplinary mobility protocol, but protocols alone are insufficient. Daily goal setting during rounds, visible mobility targets and clarification of responsibility can translate intent into action. Nurses, physiotherapists, physicians and respiratory therapists coordinate sedation, lines, ventilation and activity.

Training should include device management, emergency response, assistance techniques and outcome measurement. Mobility champions can support practice, but programmes should not depend on one individual. Audit and feedback can identify missed opportunities and unequal access.

Family members may encourage participation and provide baseline information, but should not be used as untrained staff. Clear explanations reduce fear. Patient dignity, privacy and preferences remain important even during technically complex mobilization.

Resource-limited ICUs can prioritize low-cost elements: positioning, active exercise, sitting, standing and walking with trained staff. Lack of advanced equipment does not justify avoidable immobilization. Conversely, insufficient staff or unsafe monitoring should not be ignored; progression must match capability.

Transition Beyond the ICU

ICU discharge is a transition, not the end of rehabilitation. Patients may move to a ward with fewer staff and less equipment while still needing substantial assistance. A structured handover should include baseline function, ICU Mobility Scale, strength, assistive devices, activity response and ongoing precautions.

Ward rehabilitation progresses walking, transfers, stairs, endurance and self-care in realistic contexts. Orthostatic symptoms, fatigue and cognitive impairment may become more apparent as demands increase. Therapy should coordinate with occupational, nutritional and psychological care.

Discharge destination depends on function, support and environment. Home assessment questions include stairs, bathroom access, caregiver capacity and travel for follow-up. Equipment should be prescribed after task assessment. Patient education should address pacing, falls, warning symptoms and gradual activity progression.

Post-ICU clinics can identify persistent weakness and post-intensive-care syndrome, although models vary. Community physiotherapy may use aerobic and resistance training, balance and functional goals. Exercise intensity should be based on assessment rather than assuming that every survivor remains medically fragile.

Return to work and social participation are meaningful outcomes. Improvement in walking distance does not necessarily resolve fatigue or cognitive difficulty. Rehabilitation goals should reflect the patient's life and involve appropriate referrals. Follow-up measures should include function and quality of life, not only survival.

Special Populations and Clinical Reasoning

Older adults may have frailty, sarcopenia and sensory impairment before ICU admission. Early mobilization remains relevant but may require slower progression, greater balance support and realistic goals. Maintaining transfers or avoiding new institutional care can be clinically important.

Patients with neurological, trauma or cardiac conditions require diagnosis-specific precautions. General ICU-AW frameworks cannot override intracranial pressure management, spinal stability, weight-bearing restrictions or sternotomy guidance. Physiotherapists integrate critical-care and specialty knowledge.

Obesity can increase assistance and equipment requirements but should not delay mobility solely because handling is difficult. Bariatric equipment and adequate staffing protect patient and staff safety. Underweight or malnourished patients may fatigue quickly and need coordinated nutrition.

Delirium changes communication and risk. Simple commands, familiar orientation and consistent staff can help. Agitation may preclude mobility, while hypoactive delirium can be mistaken for unwillingness. Arousal should be reassessed rather than assumed constant.

Palliative situations still benefit from goal-concordant physiotherapy. Priorities may be comfort, positioning, transfer with family or discharge home rather than progressive conditioning. Rehabilitation intensity should align with prognosis and patient preference.

Respiratory Rehabilitation and Ventilator Interaction

Physical rehabilitation in the ICU cannot be separated from respiratory management. Ventilator support, respiratory muscle load, secretion burden and gas exchange determine whether a patient can participate and how activity should progress. The physiotherapist should understand the mode of ventilation, oxygen requirements, airway type and recent trends rather than relying on a single numerical observation. A stable patient receiving substantial support may be safer to mobilize than a patient on low support whose condition is deteriorating.

Position change affects ventilation-perfusion relationships and work of breathing. Upright sitting can improve lung volumes and provide a bridge to active movement, but it may also reveal respiratory limitation. The clinician observes respiratory rate, pattern, accessory-muscle use, synchrony, oxygen saturation and subjective distress. A modest physiological response that recovers promptly may be expected; progressive distress requires regression or cessation.

Airway clearance is prescribed when assessment indicates secretion retention or ineffective cough. Techniques may include positioning, assisted cough, manual or ventilator-supported strategies and mobilization. Routine treatment without indication wastes limited energy. When secretions constrain activity, airway clearance before mobilization may improve tolerance; in other patients, movement and upright positioning are themselves the most useful respiratory interventions.

Respiratory muscle weakness can delay liberation from mechanical ventilation. Limb MRC scoring does not fully represent diaphragm or inspiratory performance. Maximal inspiratory pressure and other respiratory measures may be used when feasible, but technique and cooperation influence validity. Inspiratory muscle training requires a stable, responsive patient and a defined load. It should complement, not compete with, spontaneous breathing trials and medical weaning decisions.

Mobilization during invasive ventilation requires coordinated roles. One clinician may manage airway and ventilator tubing while others assist the patient and devices. Portable ventilators, adequate tubing length and planned routes reduce risk. The team should decide in advance how to respond to desaturation, loss of airway security or haemodynamic change. Improvised mobilization without role clarity increases preventable hazard.

Tracheostomy may facilitate communication and mobility for some patients but introduces specific handling and humidification considerations. Speaking valves, oxygen delivery and suction needs should be coordinated. Communication methods improve the patient’s sense of control and allow symptoms to be reported during exercise.

After extubation, respiratory risk does not disappear. Patients may have weak cough, dysphagia, fatigue and reduced reserve. Early walking and functional activity should continue with observation of oxygen need and recovery. Sudden respiratory decline, chest pain or new focal signs require medical evaluation rather than exercise progression.

The integrated goal is efficient participation with adequate gas exchange, manageable respiratory effort and secure devices. Separating “chest physiotherapy” from “mobility” into unrelated sessions can duplicate burden. A single patient-centred plan sequences respiratory preparation, active exercise and recovery according to the most important limitation on that day.

Outcome Measurement Across the Recovery Continuum

Outcome measurement should answer a clinical question. In the ICU, daily measures support decisions about progression and communication. At hospital discharge, they characterize assistance and equipment needs. After discharge, they evaluate recovery of endurance, participation and quality of life. Using one scale for every phase is unlikely to be adequate.

The MRC sum score addresses volitional strength and supports identification of ICU-AW. Its advantages are familiarity and minimal equipment, but ceiling effects and dependence on cooperation limit use. Clinicians should standardize positioning and instruction. A change caused by improved arousal should not be mistaken entirely for muscle recovery.

The ICU Mobility Scale records the highest mobility level and is responsive to milestones such as sitting, standing and walking. It is efficient for audit and handover. However, two patients at the same level may require different assistance or have different endurance. Recording staff assistance, device, distance and symptoms adds essential detail.

The Functional Status Score for the ICU evaluates rolling, transfer from supine to sitting, sitting, sit-to-stand and walking. It provides a structured view of assistance across common tasks. The Chelsea Critical Care Physical Assessment Tool includes respiratory and physical domains. Services should select tools that staff can apply reliably rather than accumulating scores without interpretation.

Once the patient reaches the ward, gait speed, Timed Up and Go, sit-to-stand testing and walking endurance may be appropriate. The six-minute walk test can characterize submaximal capacity later in recovery when the patient can walk safely. Balance assessment and fall history are relevant, especially after prolonged weakness or neuropathy.

Patient-reported outcome measures capture symptoms and participation not visible during a brief test. Fatigue, breathlessness, pain, confidence, anxiety and ability to resume roles influence recovery. Health-related quality-of-life tools and post-intensive-care follow-up can complement performance measures. Proxy reports may help early but should not replace the patient's report once communication improves.

Measurement burden must remain proportionate. Repeated testing can fatigue critically ill patients. A core set may include one impairment measure, one mobility measure and documentation of meaningful activity. Additional tests are added when they change management. Timing should be consistent enough to interpret trends.

Discharge summaries should state actual function rather than only scores. Whether the patient walks independently, needs a frame, requires one-person assistance or cannot climb stairs is immediately actionable. Scores support, but do not substitute for, this description. Longitudinal linkage between ICU, ward and community measures is a research and service priority because recovery often extends for months.

A Detailed Bedside Progression Framework

A practical rehabilitation pathway begins each day with readiness screening and a patient-specific goal. The goal may be active limb exercise, sitting out of bed, standing, transfer or walking. It should reflect the highest safe activity likely to be achieved with available staff and equipment. Previous performance guides but does not determine current readiness.

Level 1 focuses on prevention of secondary complications and initiation of activity. Positioning protects skin and joints, while range of motion addresses stiffness. The physiotherapist seeks any voluntary activation and uses simple commands. Family or familiar cues may help orientation. Passive movement is used when necessary but active contribution is encouraged at every opportunity.

Level 2 develops bed mobility and antigravity control. Exercises include heel slides, bridging where appropriate, upper-limb reaching, rolling and supported sitting. The patient learns to coordinate breathing with effort. Assistance is titrated so that movement remains successful without removing all challenge. Short rests limit excessive fatigue.

Level 3 emphasizes edge-of-bed sitting. Feet are supported when possible, and trunk alignment, head control and balance reactions are observed. Reaching and weight shift can increase challenge. Orthostatic response is monitored. Sitting should have a therapeutic purpose rather than leaving a patient unsupported and exhausted.

Level 4 introduces verticalization and standing. A tilt table may be appropriate for severe weakness or orthostatic intolerance, while a standing aid can facilitate weight bearing. Sit-to-stand practice is preferred when sufficient activation exists. Knee control, trunk extension and ability to follow commands determine assistance. Staff should avoid pulling through vulnerable shoulders.

Level 5 includes transfers and stepping. Bed-to-chair transfer may use a pivot, stepping or mechanical device according to ability. Marching on the spot tests weight shift before walking. The clinician assesses foot clearance, balance, device control and physiological tolerance. A transfer completed with excessive assistance may not be the correct level for repeated training.

Level 6 develops walking. Initial distance can be only a few metres with a walker, portable ventilation and several staff. Progression may increase distance, repetitions or reduce assistance. Turns and destination tasks add function. Quality and safety take precedence over impressive distance.

Level 7 builds endurance, strength and independence. Repeated sit-to-stand, corridor walking, step practice and resistance exercise prepare for ward and home demands. Training intensity can increase as medical instability resolves. Recovery intervals and the next-day response guide dose.

Regression is permitted. Procedures, sleep disruption, infection or dialysis may temporarily reduce performance. The team should preserve achievable activity rather than abandon rehabilitation entirely. A lower-dose session can maintain engagement. Conversely, unexplained decline should prompt clinical review.

At every level, success is defined by meaningful participation, acceptable symptoms, physiological recovery and progression toward the patient's goals. The framework is not a race to walking. It ensures that activity is deliberate, graded and documented, while protecting the patient from both unnecessary bed rest and poorly controlled intensity.

Limitations and Research Priorities

Definitions of early mobilization, usual care and ICU-AW vary. Trials combine different diagnoses and illness severities, while intervention dose is often poorly described. These limitations complicate comparison and may dilute effects.

Strength testing excludes patients unable to follow commands, potentially missing the sickest group. Mobility outcomes capture activity but not mechanisms. Long-term studies face mortality and loss to follow-up. Future work should use core outcomes across impairment, activity, participation and quality of life.

Dose-response research is essential. Trials should report start time, frequency, intensity, duration, assistance and adverse events. Adaptive interventions may be more appropriate than fixed protocols because readiness changes daily.

Implementation research should measure not only eligibility but actual delivered activity and reasons for missed sessions. Economic analyses should include staffing and downstream disability. Research in resource-limited settings is needed.

The relationship between muscle biology and functional recovery requires further study. Biomarkers or imaging may clarify mechanisms, but patient-centred function remains the key outcome. Evidence should guide proportionate claims and avoid equating any movement with sufficient rehabilitation.

Future research should also identify treatment responders. Patients with sepsis, trauma, neurological disease, frailty or prolonged ventilation may not respond similarly to one protocol. Stratified analyses can determine whether baseline strength, mobility, inflammation, nutrition or sedation exposure modifies benefit. Trials should include patients who cannot initially follow commands, because excluding them limits relevance to severe critical illness.

Long-term follow-up requires coordination across services. Studies should link ICU treatment exposure with ward rehabilitation, discharge destination and community exercise. Without measuring later therapy, it is difficult to attribute recovery to the ICU phase alone. Patient and caregiver perspectives can identify burdens and outcomes overlooked by clinical measures.

Finally, studies should report harms and opportunity costs transparently. Mobilization may be safe yet require substantial staffing; resources directed toward low-risk patients may reduce access for those with greater need. Pragmatic evaluations should examine scalable staffing models, training requirements and equity. The goal is not merely to prove that mobilization can occur, but to determine how high-quality rehabilitation can be delivered consistently to the right patient at the right dose.

Conclusion

ICU-AW is a frequent and consequential complication of critical illness arising from interacting catabolism, inflammation, disuse and neuromuscular dysfunction. Physiotherapists contribute through early recognition, reliable assessment, prevention of avoidable immobility and progressive activity across the care continuum.

Evidence published from 2012 through 2020 indicates that early mobilization is generally safe when screened and coordinated, and may improve strength, mobility and selected ICU outcomes. Effects on mortality and long-term independence remain inconsistent. Treatment should progress from active participation in bed to sitting, standing, transfers, walking and conditioning according to physiological response.

Rehabilitation must continue beyond ICU discharge, with clear handover and patient-centred goals. Future studies need standardized definitions, better dose reporting and long-term outcomes. The central clinical principle is neither bed rest nor indiscriminate intensity, but timely, individualized and safely progressive rehabilitation.

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