Case Report

Early Rehabilitation in adult and paediatric critically ill patients with respiratory failure, sepsis, and pneumonia: Case series

Putri Alfaridy Lubis[1], Siti Chandra Widjanantie[2], Anitta Florence Stans Paulus[2], Thariq Emyl Taufik Hasibuan[3], Ernita Akmal[3], Navy G. H. M. Lolong Wulung[3], Saad Chalid Badegesh[4], Hening Laswati Putra[5]

[1]Fellowship of Intensive Care Rehabilitation, Department of Physical Medicine and Rehabilitation, Riau University Hospital, Pekanbaru, Indonesia
[2]Physical Medicine and Rehabilitation Division, Faculty of Medicine Universitas Indonesia, Persahabatan General Hospital, Jakarta, Indonesia
[3]Anesthesiology and Intensive Care Division, Persahabatan General Hospital, Jakarta, Indonesia
[4]Pediatric Emergency and Intensive Care Division, Persahabatan General Hospital, Jakarta, Indonesia
[5]Department of Physical Medicine and Rehabilitation, Faculty of Medicine Universitas Airlangga, Surabaya, Indonesia

Abstract

Background: Critically ill patients with acute respiratory failure, sepsis, pneumonia, and complex comorbidities are at risk of prolonged ventilator dependence, impaired airway clearance, intensive care unit-acquired weakness (ICU-AW), and post-intensive care syndrome (PICS). Early, structured rehabilitation may support recovery when it is individualized, safety-monitored, and integrated with intensive care management.

Case: This retrospective case series describes three patients treated in the adult ICU and pediatric ICU of Persahabatan General Hospital, Jakarta, Indonesia, who received individualized, physiatrist-led rehabilitation. Case 1 was a 31-year-old man with class III obesity, uncontrolled type 2 diabetes mellitus, hypertension, type II respiratory failure, sepsis and community-acquired pneumonia (CAP). Case 2 was a 44-year-old man with severe CAP, type II respiratory failure, sepsis shock, prolonged mechanical ventilationand suspected critical illness polyneuropathy/myopathy. Case 3 was a girl aged 3 years and 3 months with status epilepticus, sepsis, bronchopneumonia, urinary tract infection and trichuriasis requiring mechanical ventilation.

The rehabilitation program combined positioning, airway clearance techniques, mechanical insufflation-exsufflation or manually assisted cough strategies, respiratory muscle facilitation, neuromuscular electrical stimulation (NMES), range-of-motion exercise, progressive mobilization, and caregiver training. Functional status was monitored using ICU Mobility Scale (IMS), Chelsea Critical Care Physical Assessment Tool (CPAx), Medical Research Council Sum Score (MRC-SS), Functional Status Scale (FSS), and grip strength. After 2 weeks, case 1 showed improvement in the IMS from 0 to 6, CPAx from 2 to 27, and MRC-SS from 40 to 60, accompanied by successful ventilator weaning. After 3 weeks, case 2 demonstrated an increase in CPAx from 5 to 20, IMS from 1 to 4, MRC-SS from 24 to 32, handgrip strength from 5.2 to 11.3 kg in both arms, and peak cough flow from 45 to 79 L/min. Case 3 showed improvement in FSS from 23/36 to 16/36 and IMS from 0 to 6 after 3 weeks.

Discussion: This case series suggests that early structured, multidisciplinary rehabilitation was feasible in medically complex ICU/PICU patients. The combination of positioning, progressive mobilization, airway clearance techniques, NMES, and caregiver engagement was associated with improved mobility, airway clearance, ventilator liberation, and functional status in selected adult and pediatric patients with respiratory failure and sepsis.

Conclusion: Because of the retrospective design, small sample size, absence of a control group, and lack of post-discharge follow-up, causal conclusions cannot be made. Larger prospective studies are needed to define optimal protocols, safety criteria, dosage and long-term outcomes.

Keywords: Intensive care, rehabilitation, early mobilization, ventilator weaning, and functional recovery

Corresponding Author:
Putri Alfaridy Lubis
Fellowship of Intensive Care Rehabilitation, Department of Physical Medicine and Rehabilitation, Riau University Hospital, Pekanbaru, Indonesia

putrialfaridylubis@gmail.com

Submitted: June 2026
Accepted: June 2026
Published: June 2026

Cite this:
Lubis PA, Widjanantie SC, Paulus AFS, Hasibuan TET, Akmal E, Wulung NGHM, Badegesh, Putra HL. Early Rehabilitation in adult and paediatric critically ill patients with respiratory failure, sepsis, and pneumonia: Case series. Persahabatan Respi J 2026;2(1):59-69

Persahabatan Respirology Journal
Vol. 1 No. 1: 1-5
e-ISSN: 3124-0518
DOI:

INTRODUCTION

Critically ill patients with respiratory failure caused by pneumonia, sepsis, and other severe systemic illnesses commonly develop prolonged dependence on mechanical ventilation, impaired airway clearance, and ICU-AW. These complications contribute to delayed recovery, reduced physical function, and an increased risk of PICS[1–3]. Early mobilization and rehabilitation have been reported as feasible in selected mechanically ventilated patients. They may improve mobility, enhance ventilator weaning, reduce ICU length of stay, and improve functional outcomes when delivered by trained multidisciplinary teams [4–6].

Despite growing interest in ICU rehabilitation, evidence remains limited for several clinically challenging subgroups, including younger adults with severe metabolic comorbidity, patients requiring prolonged ventilatory support, and critically ill children with neurologic and infectious conditions. In many resource-constrained settings, rehabilitation pathways are also less standardized, and published experience remains sparse.

This case series describes the implementation of a structured, goal-directed, physiatrist-led rehabilitation program in three medically complex patients admitted to the ICU or PICU at Persahabatan General Hospital. The report focuses on clinical feasibility, intervention components, functional progression, ventilator liberation, and practical lessons for integrated ICU/PICU rehabilitation pathways.

METHODS

Study design and setting

This was a retrospective, single-centre case series that included three patients admitted to the ICU/PICU at Persahabatan General Hospital, Jakarta, Indonesia, between September and November 2025. The manuscript was prepared according to the principles of transparent case-series reporting, emphasizing clinical context, intervention description, outcome measurement, and limitations.

Case selection and data sources

Cases were selected from intensive care rehabilitation fellowship reports because they represented clinically challenging but typical scenarios encountered in ICU/PICU rehabilitation: (1) a young adult with class III obesity, metabolic comorbidity, sepsis, and respiratory failure; (2) a middle-aged adult with severe community-acquired pneumonia, septic shock, prolonged mechanical ventilation, and tracheostomy; and (3) a preschool child with neurologic critical illness, severe sepsis, bronchopneumonia, and prolonged ventilatory support. Data were extracted from available clinical summaries, rehabilitation assessments, serial functional measurements, respiratory support documentation, diaphragm ultrasound images, and discharge summaries.

Rehabilitation assessment and outcomes

For each patient, baseline and follow-up data included demographics, comorbidities, ICU admission diagnosis, organ support requirements (such as mechanical ventilation, vasopressors, sedation), participation status, airway clearance problems, muscle weakness, mobility level, and discharge status. Rehabilitation goals and rehabilitation interventions like positioning, mobilization, NMES, cough assist, air stacking, and range-of-motion exercises. Consciousness examination using Richmond Agitation-Sedation Scale (RASS). Functional and clinical outcome measures were selected according to age and clinical condition. Adult ICU mobility was measured with the ICU Mobility Scale (IMS), an 11-point scale ranging from 0 (no active movement) to 10 (independent walking)[7]. Overall adult physical function was assessed using the Chelsea Critical Care Physical

Assessment Tool (CPAx), which evaluates respiratory function, cough, mobility, grip strength, and functional activity in critically ill adults[8]. Limb strength was measured using the Medical Research Council Sum Score (MRC-SS; range 0-60, higher scores indicating better strength). Pediatric function was evaluated using the Functional Status Scale (FSS), where higher scores indicate greater functional impairment[9]. Critical-Care Pain Observation Tool (CPOT), grip strength, and peak cough flow were documented when available.

Rehabilitation framework

The rehabilitation program was led by a physiatrist and delivered in collaboration with intensivists, pediatric intensive care specialists, nurses, physiotherapists, nutritionists, and family caregivers. The general rehabilitation framework included daily goal setting, airway clearance, positioning, prevention of contracture and pressure injury, neuromuscular preservation, respiratory muscle facilitation, progressive mobilization, and caregiver education. Interventions were advanced according to physiologic stability, respiratory support, arousal, command following, oxygenation, hemodynamic response, fatigue, pain, and clinical team consensus. Exact intervention dose and device settings should be verified from source clinical records before final submission.

RESULTS

Case 1:

A 31-year-old man with class III obesity (Body mass index 44.1 kg/m²), uncontrolled type 2 diabetes mellitus, and hypertension was admitted with type II respiratory failure, sepsis secondary to community-acquired pneumonia (Pneumonia Severity Index 131), and altered consciousness. He required endotracheal intubation and invasive mechanical ventilation.

At initial rehabilitation assessment, he was deeply sedated (RASS –4), had an ineffective cough, poor spontaneous respiratory effort, and complete dependence in all activities of daily living (ADL). Baseline measures included an IMS 0, CPAx 2, and the Critical-Care Pain Observation Tool (CPOT) 1. Echocardiography showed preserved left ventricular ejection fraction (LVEF 52%) with concentric remodeling, consistent with hypertensive heart disease.

Rehabilitation goals were to facilitate ventilator weaning, improve arousal and participation, and improve airway clearance, preserve neuromuscular function, and initiate safe mobilization. Intervention included upright and tilt-bed positioning to boost diaphragmatic excursion and ventilation, bilateral phrenic nerve/diaphragm-focused NMES to prevent ventilator-induced diaphragmatic dysfunction (VIDD), mechanical insufflation-exsufflation to improve inspiratory volume and peak cough flow to help airways clearance, passive and assisted ROM exercise, bridging exercise, progressive mobilization, caregiver training in manual cough assistance exercise, air stacking, and diaphragmatic breathing.

Over 2 weeks, sedation was reduced and command following improved. Functional scores increased substantially, with CPAx rising from 2 to 27, IMS from 0 to 6, MRC-SS from 40 to 60, and grip strength from 20 to 23 for each arm. He was successfully weaned from the mechanical ventilation to high-flow nasal oxygen and subsequently to room air. At ward transfer, he was able to stand with a walker and perform basic ADL with minimal assistance.

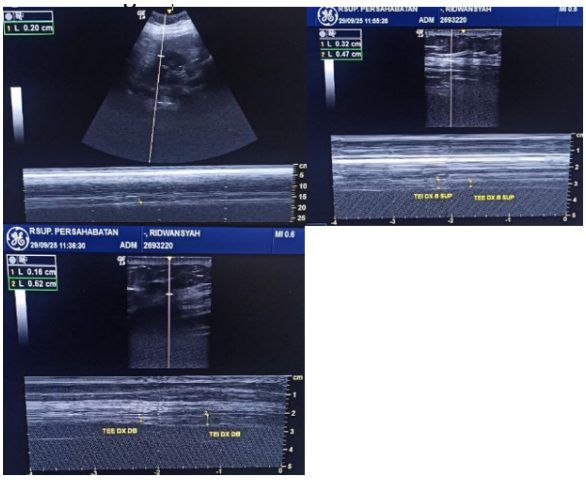

Figure 1. Case I: Diaphragm ultrasonography normal and functional diaphragm (29/09/25)

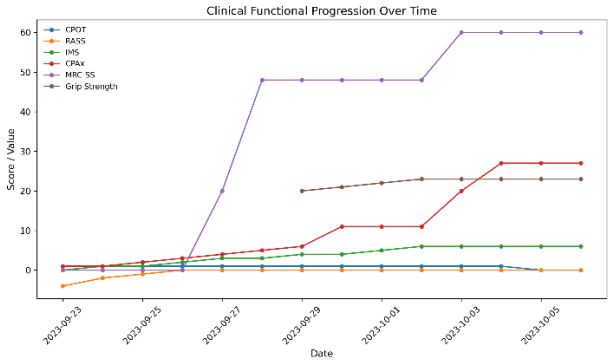

Figure 2. Case I *Clinical function progression*

Case 2:

A 44-year-old man was admitted with severe community-acquired pneumonia, type II respiratory failure, septic shock (SOFA score 4), and suspected coronary artery disease. His ICU course was complicated by prolonged mechanical ventilation and tracheostomy.

At the start of rehabilitation, he was on continuous positive airway pressure (CPAP) via tracheostomy and had retained secretions, ineffective cough, and marked generalized weakness consistent with suspected Critical Illness Polyneuropathy/ Myopathy (CIPNM). Baseline scores were IMS 1, CPAx 5, MRC-SS 24, grip strength 5,2 kg bilaterally, peak cough flow <45 L/min and CPOT 2. Comorbidities included hypertension, type 2 diabetes mellitus, active smoking history and suspected coronary artery disease.

Rehabilitation goals were airway clearance, neuromuscular preservation, mobilization, nutritional optimization in collaboration with the ICU team, and progression toward ventilator weaning.

Interventions included frequent repositioning, gluteal bridging, and pressure ulcer prevention, ROM exercise, NMES of major limb muscle groups (quadriceps, biceps, tibialis anterior) to prevent atrophy and contractures, mechanical cough assist with suctioning support, phrenic nerve/diaphragm-focused NMES, diaphragmatic breathing exercises, sitting progression, and family involvement in exercises.

After 3 weeks, the CPAx improved from 5 to 20, IMS from 1 to 4, and grip strength increased bilaterally from 5.2 kg to 11.3 kg. The MRC-SS score also increased from 24 to 32. Peak cough flow increased from less than 45 L/min to 79 L/min. He was successfully transitioned from CPAP to a T-piece and tracheostomy collar before decannulation. At ward transfer, he was able to sit independently, stand with a walker, and perform selected activities with support.

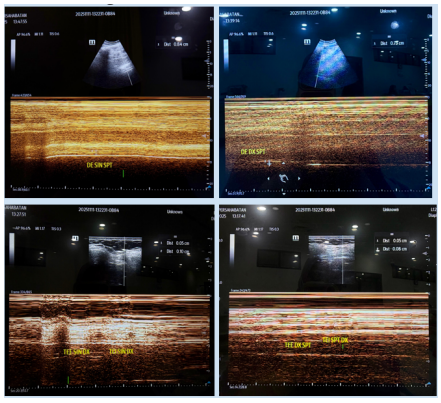

Figure 3 Case II: Diaphragm ultrasonography showing dysfunction and atrophy (11/11/25)

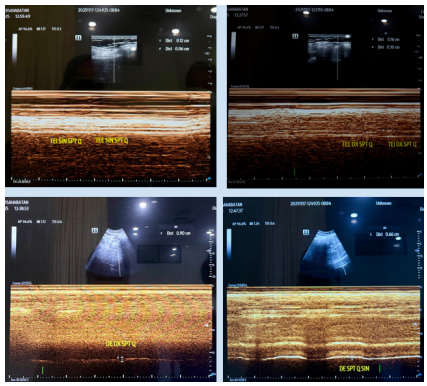

Figure 4 Case II: Improvement in diaphragmatic muscle thickness, with persistent features of diaphragmatic dysfunction (17/11/25)

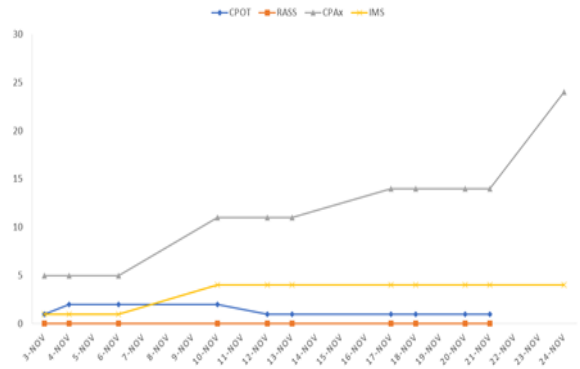

Figure 5 Case II: Clinical function progression

Case 3:

A girl aged 3 years and 3 months was admitted to the PICU with status epilepticus, severe sepsis, bilateral bronchopneumonia, urinary tract infection, and trichuriasis. She required invasive ventilation using pressure-control-assist-control mode (PC-AC) and was later transitioned to CPAP and high-flow nasal oxygen.

At rehabilitation initial assessment, she remained drowsy from sedation, showed spasticity (Ashworth scale 2) in all limbs, had an ineffective cough, and was completely dependent in ADL. Baseline measures included FSS 23/36, IMS 0, CPAx 4, and CPOT 8.

Rehabilitation goals were to improve airway clearance, support effective breathing, prevent contracture, manage tone through positioning, and promote early mobilization. The interventions included mechanical cough assist, manual air stacking, NMES of the abdominal and diaphragm-related muscles to support expiration, chest physiotherapy with vibration and percussion, prone positioning as clinically indicated, passive ROM exercise, spasticity-inhibiting positioning and handling, graded mobilization, play-based participation, and caregiver training.

Over 4 weeks, sedation was tapered, consciousness improved, FSS improved from 23/36 to 16/36, CPAx increased to 7, and IMS improved from 0 to 6. She was liberated from ventilatory support and maintained spontaneous breathing with nasal cannula oxygen. Spasticity persisted, but no contractures developed. At transfer to the pediatric ward, she could sit with support, tolerate upright positioning, and engange in simple play.

Figure 6 Case III: Caregiver training

Figure 7 Longitudinal assessment of mobility (IMS), functional status (CPAx), and pain (CPOT) during ICU rehabilitation.

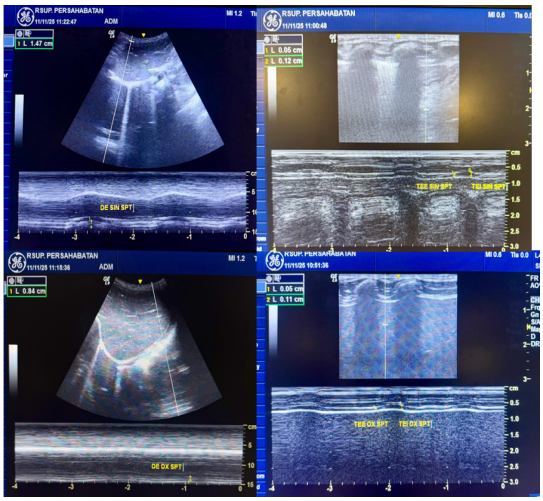

Figure 7 Case III: Diaphragm ultrasonography showing normal and functional diaphragm (12/11/25)

DISCUSSION

This case series illustrates the feasibility of implementing a structured physiatrist-led program in heterogeneous adult and pediatric ICU/PICU patients with respiratory failure, sepsis, pneumonia, and complex comorbidities.

All three patients show clinically meaningful directional improvement in mobility, respiratory function, functional status during the acute hospital phase, and ventilator weaning. Because the report is retrospective and uncontrolled, these improvements should be interpreted as associations observed during multidisciplinary critical care rather than proof of rehabilitation efficacy.

The cases show how rehabilitation can be adapted to severe obesity, prolonged ventilation, suspected ICU-acquired weakness, and pediatric neurologic critical illness without losing therapeutic coherence. Across all three cases, several elements were repeatedly important.

First, rehabilitation goals were individualized but consistent: airway clearance, ventilator weaning support, progressive mobility, preservation of muscle and joint function, and PICS prevention. Second, respiratory and physical rehabilitation were integrated rather than delivered separately. This is important because patients with pneumonia, tracheostomy, retained secretions, weak cough, and suspected ICU-AW often require airway clearance and cough augmentation before higher-level mobilization can be tolerated. Third, close coordination with the ICU team, aggressive but clinically titrated airway clearance, consistent with published recommendations emphasizing safety screening, structured protocols, and outcome monitoring[10-12].

The adult cases highlight the interaction between ventilatory support, limb weakness, diaphragm function, and mobility. Case 1 improved rapidly after sedation reduction and progressive mobilization, whereas Case 2 had a more prolonged course complicated by tracheostomy, weak cough, and suspected critical illness polyneuropathy/myopathy.

The observed increases in MRC-SS, grip strength, CPAx, IMS, and cough flow in Case 2 are clinically relevant because neuromuscular weakness and cough impairment can delay weaning, secretion clearance, decannulation, and functional independence[13,16]. Diaphragm ultrasound findings should be interpreted alongside the clinical trajectory because ultrasound thresholds and measurement technique may vary, but the modality can provide useful bedside information on diaphragm structure and function[9,10,14,17,18].

The pediatric case emphasizes that ICU rehabilitation principles need adaptation to developmental stage, neurologic status, sedation recovery, tone abnormalities, and caregiver participation. The improvement in FSS from 23/36 to 16/36 indicates reduced functional disorders, especially in the sensory and communication domains, while the increase in IMS from 0 to 6 reflects substantial mobility recovery. However, adult tools such as CPAx and IMS are not fully validated for all pediatric contexts; therefore, pediatric-specific

outcomes such as FSS and age-appropriate developmental participation should be prioritized in future reports [9,15,16].

NMES was used as an adjunctive strategy in these cases to support neuromuscular preservation and respiratory muscle facilitation when active participation was limited. The ICU literature suggests potential benefit and feasibility of NMES in selected patients, but protocols vary widely and the evidence remains heterogeneous[19,20]. Therefore, future manuscripts should report electrode placement, stimulation frequency, pulse duration, contraction quality, session duration, total number of sessions, adverse events, and reasons for non-application to support reproducibility.

The main contribution of this case series is its description of integrated ICU/PICU rehabilitation practice in an Indonesian tertiary respiratory referral hospital. The findings support the need for local ICU rehabilitation pathways that include early physiatrist involvement, daily multidisciplinary goal setting, standardized functional measures, respiratory therapy integration, caregiver training, documentation of safety events, and post-discharge follow-up to evaluate PICS and longer-term participation outcomes.

LIMITATION

This report has several limitations. It is a retrospective single-center case series involving only three patients, with no control group and no standardized follow-up beyond hospital care. Improvement cannot be attributed solely to rehabilitation because concurrent medical treatment, natural recovery, sedation reduction, infection control, ventilator management, nutrition, and nursing care almost certainly contributed.

The cases were selected from fellowship reports and may be subject to selection bias. Follow-up data after hospital discharge were also not available, so the long-term impact on functional outcomes and post-intensive care syndrome (PICS) remains unclear. Future prospective studies with larger samples, standardized protocols, and longer follow-up periods would be needed to draw more definitive conclusions.

CONCLUSION

This three-case series suggests that an early, structured, physiatrist-led rehabilitation program is feasible in selected adult and pediatric critically ill patients with respiratory failure, sepsis, and complex comorbidities, including young obese adults, middle-aged adults requiring prolonged ventilation, and young children with neurological and infectious complications.

Multimodal rehabilitation combining progressive mobilization, airway clearance, and respiratory muscle facilitation, neuromuscular preservation, and caregiver involvement is associated with improvements in ventilator weaning, functional status, mobility, and discharge outcomes.

These cases support integrating early rehabilitation into routine ICU and PICU care, even in resource-limited settings, to optimize recovery and reduce long-term disability. Causal conclusions cannot be made from this small retrospective case series.

Prospective studies with standardized protocols, detailed intervention reporting, safety monitoring, and long-term follow-up are needed to define optimal ICU/PICU rehabilitation pathways in Indonesia and similar resource-limited settings.

ACKNOWLEDGMENTS

The authors would like to thank the multidisciplinary ICU and PICU teams at Persahabatan General Hospital, Jakarta, including the physiatrist-cardiorespiration consultant, physiotherapies, intensivists, anesthesiologists, pediatric emergency and intensive care specialists, nurses, nutritionists, and allied health professionals, whose collaborative efforts were integral to the implementation of the rehabilitation programs described in this case series.

Special appreciation is extended to the patients' families for their active participation in caregiver training and home exercise programs. The authors also acknowledge the support of the Riau University Hospital, Pekanbaru, and the Department of Physical Medicine and Rehabilitation at Universitas Indonesia and Universitas Airlangga for their academic guidance throughout this work

CONFLICT OF INTEREST

The authors declare no conflict of interests. This case series was not funded or influenced by any commercial entity, and no products or devices were promoted. All interventions, including the use of Cough Assist and neuromuscular electrical stimulation (NMES), were carried out based on clinical need and current evidence, as part of routine care at Persahabatan General Hospital.

FUNDING

This case series did not receive external funding. Rehabilitation interventions were delivered as part of routine clinical care and fellowship training at Persahabatan General Hospital, Jakarta, Indonesia

REFERENCES

1. Huang CY, Daniels R, Lembo A, et al. Sepsis survivors engagement P: Life after sepsis – An international survey of survivors to understand the post-sepsis syndrome. Int J Qual Health Care. 2019;31(3):191–198.[1]
2. Borges RC, Carvalho CRF, Colombo AS, et al. Physical activity, muscle strength, and exercise capacity 3 months after severe sepsis and septic shock. Intensive Care Med. 2015;41(8):1433–1444.[2]
3. Nikayin S, Rabiee A, Hashem MD, et al. Anxiety symptoms in survivors of critical illness: a systematic review and meta-analysis. Gen Hosp Psychiatry. 2016;43:23–29.[3]
4. Needham DM, Korupolu R, Zanni JM, et al. Early physical medicine and rehabilitation for patients with acute respiratory failure: a quality improvement project. Crit Care Med. 2010;38(12 Suppl):S536–S542.
5. Bailey P, Thomsen GE, Spuhler VJ, et al. Early activity is feasible and safe in respiratory failure patients. Crit Care Med. 2007;35(1):139–145.
6. Kress JP, Hall JB. ICU-acquired weakness and recovery from critical illness. N Engl J Med. 2014;370(17):1626–1635.
7. Hodgson C, Needham D, Haines K, Bailey M, Ward A, Harrold M, et al. Feasibility and inter-rater reliability of the ICU Mobility Scale. Heart Lung. 2014;43(1):19-24. doi:10.1016/j.hrtlng.2013.11.003.
8. Corner EJ, Wood H, Englebretsen C, Thomas A, Grant RL, Nikoletou D, et al. The Chelsea Critical Care Physical Assessment tool (CPAx): validation of an innovative new tool to measure physical morbidity in the general adult critical care population. Physiotherapy. 2013;99(1):33-41. doi:10.1016/j.physio.2012.01.003.
9. Pollack MM, Holubkov R, Glass P, Dean JM, Meert KL, Zimmerman J, et al. Functional Status Scale: new pediatric outcome measure. Pediatrics. 2009;124(1):e18-e28. doi:10.1542/peds.2008-1987

10. Hodgson CL, Stiller K, Needham DM, Tipping CJ, Harrold M, Baldwin CE, et al. Expert consensus and recommendations on safety criteria for active mobilization of mechanically ventilated critically ill adults. Crit Care. 2014;18(6):658. doi:10.1186/s13054-014-0658-y.
11. Lang JK, Paykel MS, Haines KJ, Hodgson CL. Clinical practice guidelines for early mobilization in the ICU: a systematic review. Crit Care Med. 2020;48(11):e1121-e1128. doi:10.1097/CCM.0000000000004574.
12. Poulsen JB, Møller K, Kehlet H, Perner A. Long-term physical outcome in patients with septic shock. Acta Anaesthesiol Scand. 2009;53(6):724–730.
13. Dres M, Dube BP, Mayaux J, Delemazure J, Reuter D, Brochard L, et al. Coexistence and impact of limb muscle and diaphragm weakness at time of liberation from mechanical ventilation in medical intensive care unit patients. Am J Respir Crit Care Med. 2017;195(1):57-66. doi:10.1164/rccm.201602-0367OC.
14. Marques MR, Pereira JM, Paiva JA, et al. Ultrasonography to access diaphragm dysfunction and predict the success of mechanical ventilation weaning in critical care: a narrative review. J Ultrasound Med. 2024;43(1):223–236. doi:10.1002/jum.16363.
15. Walker TC, Kudchadkar SR. Early mobilization in the pediatric intensive care unit. Transl Pediatr. 2018;7(4):308–313. doi:10.21037/tp.2018.09.02.
16. Madurga-Revilla P, López-Piñón J, Samper-Villagrasa P, et al. Functional status assessment after pediatric neurointensive care: a new Functional Status Scale (FSS). Neurología. 2020;35(3):211–217. doi:10.1016/j.nrleng.2017.11.008.
17. Daniel Martin A, Smith BK, Gabrielli A. Mechanical ventilation, diaphragm weakness and weaning: a rehabilitation perspective. Respir Physiol Neurobiol. 2013;189(2):377–383.
18. Van Doorn JLM, Wijntjes J, Saris CGJ, et al. Association of diaphragm thickness and echogenicity with age, sex, and body mass index in healthy subjects. Muscle Nerve. 2022;66(2):197–202.
19. Zhang X, et al. Effect of neuromuscular electrical stimulation combined with early rehabilitation therapy on mechanically ventilated patients: a prospective randomized controlled study. BMC Pulm Med. 2023. doi:10.1186/s12890-023-02481
20. Daum N, Drewniok N, Bald A, et al. Neuromuscular electrical stimulation for early rehabilitation in critically ill patients: a systematic review of applied protocols. Crit Care. 2026;30(1):92. Published 2026 Feb 10. doi:10.1186/s13054-026-0587

SUMMARY TABLES

Table 1. Baseline characteristics and clinical presentation

Case	Patient profile	Primary ICU/PICU diagnoses	Respiratory/organ support	Baseline rehabilitation problems
1	31-year-old man; BMI 44.1 kg/m2; uncontrolled type 2 diabetes mellitus; hypertension	Type II respiratory failure; sepsis due to community-acquired pneumonia; altered consciousness	Endotracheal intubation and invasive mechanical ventilation; no vasopressor reported in source summary	RASS -4; ineffective cough; poor spontaneous respiratory effort; dependent ADL; IMS 0; CPAx 2; CPOT 1
2	44-year-old man; hypertension; type 2 diabetes mellitus; active smoking history; suspected coronary artery disease	Severe community-acquired pneumonia; type II respiratory failure; septic shock; suspected CIPNM	Prolonged invasive ventilation; tracheostomy; CPAP via tracheostomy at rehabilitation start	Retained secretions; ineffective cough; generalized weakness; IMS 1; CPAx 5; MRC-SS 24; grip 5.2 kg; peak cough flow <45 L/min
3	Girl aged 3 years and 3 months; incomplete immunization status reported	Status epilepticus; severe sepsis; bilateral bronchopneumonia; urinary tract infection; trichuriasis	Invasive ventilation with PC-AC, then CPAP and high-flow nasal oxygen	Drowsiness after sedation; spasticity in all limbs; ineffective cough; complete ADL dependence; FSS 23/36; IMS 0; CPAx 4; CPOT 8

Abbreviations: ADL, activities of daily living; BMI, body mass index; CIPNM, critical illness polyneuropathy/myopathy; CPAx, Chelsea Critical Care Physical Assessment Tool; CPAP, continuous positive airway pressure; CPOT, Critical-Care Pain Observation Tool; FSS, Functional Status Scale; IMS, ICU Mobility Scale; MRC-SS, Medical Research Council Sum Score; PC-AC, pressure-control assist-control; PICU, pediatric intensive care unit; RASS, Richmond Agitation-Sedation Scale.

Table 2. Rehabilitation goals and intervention components

Case	Rehabilitation goals	Core respiratory interventions	Core neuromuscular/mobility interventions	Caregiver/family role
1	Ventilator liberation; improved arousal; airway clearance; neuromuscular preservation; early mobilization	Upright/tilt-bed positioning; mechanical insufflation-exsufflation; manual cough assist; air stacking; diaphragmatic breathing; diaphragm-focused NMES	Passive and active-assisted ROM; bridging; progressive mobilization; standing with walker by ward transfer	Training in manual cough assist, air stacking, breathing exercise, and basic mobility assistance
2	Secretion control; cough effectiveness; CIPNM management; pressure injury prevention; mobilization; weaning progression	Mechanical cough assist plus suctioning; diaphragmatic breathing; phrenic/diaphragm-focused NMES; airway clearance during tracheostomy weaning	Repositioning; ROM; gluteal bridging; limb NMES; sitting and edge-of-bed training; transition toward standing with walker	Family-assisted exercise practice and reinforcement of airway clearance and mobility activities
3	Airway clearance; effective breathing; contracture prevention; tone management; play-based mobilization; caregiver training	Mechanical cough assist; manual air stacking; chest physiotherapy; vibration/percussion; prone positioning when clinically indicated; abdominal/diaphragm-related NMES	Passive ROM; spasticity-inhibiting positioning/handling; graded mobilization; supported sitting; simple play activities	Caregiver training for positioning, ROM, airway clearance support, and continuation after PICU transfer

Author confirmation needed before submission: frequency, duration, intensity, progression criteria, NMES parameters, mechanical insufflation-exsufflation settings, and safety stop criteria should be inserted if available.

Table 3. Functional and respiratory outcomes

Case	Follow-up period	Mobility/function	Strength/cough	Ventilatory outcome	Functional status at ICU/PICU transfer
1	2 weeks	IMS 0 to 6; CPAx 2 to 27	MRC-SS 40 to 60; grip 20 to 23 kg in each arm	Invasive MV to HFNO, then room air	Able to stand with walker; basic ADL with minimal assistance
2	3 weeks	IMS 1 to 4; CPAx 5 to 20	MRC-SS 24 to 32; grip 5.2 to 11.3 kg bilaterally; peak cough flow <45 to 79 L/min	CPAP via tracheostomy to T-piece/tracheostomy collar before decannulation	Sitting independently; standing with walker; selected ADL with support
3	4 weeks	FSS 23/36 to 16/36; IMS 0 to 6; CPAx 4 to 7	Spasticity persisted but no contractures developed; cough effectiveness improved clinically	Liberated from ventilatory support; nasal cannula oxygen	Supported sitting; upright tolerance; simple play participation

Interpretation note: for IMS, CPAx, MRC-SS, grip strength, and peak cough flow, higher values generally indicate better performance. For pediatric FSS, lower values indicate better functional status.