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NARRATIVE REVIEW

Rehabilitation and the post-intensive care syndrome across the recovery continuum: a narrative review

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Abstract

Purpose: Improved survival from critical illness has produced a growing population of intensive care unit (ICU) survivors with new or worsened physical, cognitive, and mental-health impairment, defined as post-intensive care syndrome (PICS), and frequent distress among families/caregivers (PICS-family, PICS-F). This narrative review synthesises the evidence in adults treated in high-resource settings.

Methods: Rather than a formal guideline process, we used a structured descriptive approach: for each recommendation, we identified the predominant study design, assessed the consistency of findings, summarised uncertainties, and assigned an evidence-strength label (high, moderate, low, or insufficient).

Results: We summarise the definition of PICS and its overlap with related constructs (post-sepsis morbidity, chronic critical illness, post-COVID conditions, and frailty); the mechanisms linking acute injury to persistent disability, including skeletal-muscle pathobiology, neuroinflammation, mitochondrial and neuroendocrine dysfunction, and epigenetic change; and the instruments assessing the three PICS core domains (recommending a two-step assessment approach), as well as quality of life, across the care continuum. We describe preventive and rehabilitative interventions from the ICU (e.g., the ABCDEF bundle that includes light/no sedation, delirium prevention, early mobilisation and family participation) through the ward to the post-hospital phase, the heterogeneous organisation of post-ICU recovery services, PICS-F, the educational and cultural change needed, and the health-system and policy context. PICS-F affects 20-60% of relatives; nurse-led family interventions seem promising.

Conclusion: The evidence base remains limited and heterogeneous, preventing firm recommendations. Research priorities include harmonised outcome measurement, phenotyping of recovery trajectories, the optimal dose and timing of rehabilitation, and rigorous comparison of follow-up models.

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Visual abstract:

REHABILITATION AND THE POST-INTENSIVE CARE SYNDROME ACROSS THE RECOVERY CONTINUUM

Narrative Review

Background

- PICS encompasses physical, cognitive, and mental health impairments after critical illness.
- PICS-F affects 20-60% of family members, highlighting the need to engage and support families from ICU to follow-up.
- Recovery extends across the continuum of critical illness and rehabilitation.
- This review summarises recommendations for prevention, rehabilitation, and long-term follow-up.

	Physical function	Cognitive function	Mental health
Step 1 Screening	TUG and Handgrip strength	Mini-Cog and ANT	PHQ-4 and GAD-2
	if positive	*if positive*	*if positive*
Step 2 Comprehensive assessment	2MWT or 6MWT and SPPB	TMT AB and MoCA or MMSE	PHQ-8 and GAD-7 and IES-R or PCL-5

Adapted from Spies et al. J Intensive Care Soc. 2021;22(2):159–174.

2/6MWT . . . 2/6-Minute Walk Test
ANT . . . Animal Naming Test
GAD-2/7 . . . Generalized Anxiety Disorder-2/7
ICU . . . Intensive Care Unit
ABCDEF bundle . . . Pain management, awakening/breathing trials, sedation, delirium, mobility, family engagement
IES-R . . . Impact of Event Scale–Revised
Mini-Cog . . . Mini-Cog test
MMSE . . . Mini-Mental State Examination
MoCA . . . Montreal Cognitive Assessment
PCL-5 . . . PTSD Checklist for DSM-5
PHQ-4/8 . . . Patient Health Questionnaire-4/8
PICS-(F) . . . Post-Intensive Care Syndrome (Family)
SPPB . . . Short Physical Performance Battery
TMT A/B . . . Trail Making Test, Parts A and B
TUG . . . Timed Up and Go test

Findings

- PICS is a dynamic process across the continuum, shaped by patient factors, ICU exposures, rehabilitation and family context.
- Higher ABCDEF bundle performance is associated with less delirium, shorter ventilation and ICU stay.
- Rehabilitation should be individualised across the recovery continuum, with no single follow-up model fitting all survivors.
- We propose a pragmatic two-step screening at 3 months to target multidisciplinary follow-up.

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Introduction

Survival from critical illness has improved substantially over recent decades because of advances in evidence-based intensive care, resulting in a growing population of intensive care unit (ICU) survivors worldwide [1]. This success, however, has revealed a substantial burden of long-term sequelae affecting physical, cognitive, and psychological health [2, 3]. These impairments persist for months to years after ICU discharge and are conceptualised as the post-intensive care syndrome (PICS), defined as new or worsening dysfunction in one or more of these domains following critical illness [4]. The burden frequently extends to relatives, in whom anxiety, depression, post-traumatic stress, and prolonged grief are described as PICS family (PICS-F) [5].

The development of PICS is multifactorial. Pre-morbid conditions, illness severity and the duration of organ failure, systemic inflammation, prolonged immobilisation, deep sedation, delirium, selected drug exposures, and metabolic and neuroendocrine alterations have all been implicated [6–8]; these determinants are considered in more detail below. Recognition of PICS/PICS-F reflects a paradigm shift in intensive care, expanding the focus from short-term survival to long-term functional recovery [3]. A mechanistic understanding of PICS may help to predict vulnerability, avoid iatrogenic harm, guide rehabilitative interventions, identify therapeutic targets, and optimise long-term outcomes.

The European Society of Intensive Care Medicine (ESICM) has recognised the importance of long-term outcomes after critical illness by establishing a new Rehabilitation and PICS Section. This narrative review complements the Section's position paper: whereas the position paper sets out the formal ESICM positions, the present article provides the broader evidence synthesis that supports them. Its scope is deliberately limited to adults treated in high-resource settings.

Methods

Because this article is a narrative review, the strength of the evidence underpinning each recommendation was appraised using a structured descriptive approach rather than a formal guideline process [9–11]. For every recommendation, we identified the predominant study design contributing the relevant evidence (randomised-controlled trials, observational studies, or expert consensus and guideline opinion), judged the consistency and direction of findings across the available studies [12], and summarised the principal residual uncertainties—for example, an unknown optimal dose, timing, or target population, or a benefit confined to short-term outcomes. On this basis, each recommendation was assigned a descriptive evidence-strength label (high, moderate, low, or insufficient to support a firm recommendation) reflecting the authors' judgement. This pragmatic categorisation is intended to make the evidence base transparent and to distinguish well-supported from provisional recommendations; it does not constitute a systematic search, quantitative synthesis, or formal certainty rating, and, therefore, the labels should be read as indicative [11, 13].

Defining PICS and distinguishing it from related conditions

Current definition

The 2012 consensus defines PICS as new or worsening impairment in physical, cognitive, or mental-health status arising after critical illness and persisting beyond acute hospitalisation. Physical impairments include ICU-acquired weakness (ICUAW), reduced exercise capacity, and functional limitations that diminish activities of daily living and delay return to work. Cognitive impairments involve deficits in memory, attention, and executive function, with effects that have been likened to those of moderate traumatic brain injury [14]. Psychological impairments encompass depression, anxiety, and post-traumatic stress disorder (PTSD). These deficits frequently co-occur and contribute to reduced quality of life, increased caregiver burden, and elevated healthcare utilisation long after discharge [4].

Conceptual boundaries and ongoing debate

Although the umbrella term PICS has raised awareness of persistent post-critical-illness morbidity, the current definition has limitations that constrain its use in practice and research, including the absence of standardised diagnostic criteria and severity grading. Two questions recur. The first issue concerns timing. Impairments associated with PICS may originate during the ICU stay but become clinically evident only after discharge. Therefore, PICS can be operationally defined as new or worsening physical, cognitive, psychological, or social impairment recognised from at least three months after hospital discharge onwards, while acknowledging that risk develops earlier and that prevention begins in the ICU [15, 16].

The second issue concerns the number of domains that must be affected. According to the original definition, PICS requires impairment in at least one domain. This broad criterion is consistent with the heterogeneous nature of post-ICU morbidity, in which physical, cognitive, psychological, and social sequelae may occur either in isolation or in combination. Indeed, co-occurring impairment across multiple domains appears to be less frequent, affecting approximately 25% of ICU survivors at 3 months and 21% at 12 months. This heterogeneity has led some authors to emphasise that PICS should be regarded as an umbrella construct rather than a single disease entity. In this context, requiring impairment in at least two domains may be useful for defining a more specific research phenotype and distinguishing multidimensional PICS from established single-domain conditions, such as isolated ICUAW [16, 17]. However, such a threshold would increase specificity at the expense of sensitivity, as many survivors experience clinically relevant post-ICU morbidity limited to a single domain. Moreover, impairment in any individual PICS domain may still be associated with reduced functional status and health-related quality of life (HRQoL) [18]. For these reasons, we would not currently recommend changing the established operational definition based on impairment in at least one domain.

Overlap with related conditions

PICS overlaps with several related constructs, and disentangling them is important for both clinical care and research. Persistent morbidity after sepsis (often described as post-sepsis morbidity or "post-sepsis syndrome") and, more recently, post-COVID conditions share many features with PICS [6, 19]. Chronic critical illness and myalgic encephalomyelitis/chronic fatigue syndrome (ME/CFS) present similar diagnostic challenges that remain poorly delineated [20, 21]. Attribution is further complicated by pre-existing cognitive impairment, psychiatric illness, and physical disability. In addition, long-term impairments may reflect the underlying disease that necessitated ICU admission or complications occurring during the course of critical illness, such as stroke, myocardial infarction, traumatic injury, or hypoxic brain injury. These conditions may produce physical, cognitive, or psychological deficits that overlap substantially with PICS, making attribution of persistent impairments to critical illness alone challenging. Therefore, assessment of PICS should always be interpreted within the context of the patient's pre-existing health status, primary diagnosis, and ICU course. Frailty occupies a special position: it is both a well-established risk factor for critical illness and a recognised consequence of it, creating a bidirectional relationship that further blurs the distinction between pre-existing vulnerability and sequelae of critical illness [22].

Biological mechanisms of long-term impairment

Long-term impairment after critical illness likely reflects biological processes initiated during the acute phase and, in some patients, persisting into recovery, particularly within host-response pathways and skeletal muscle [23, 24]. The strongest evidence supports early neuromuscular injury and rapid skeletal-muscle wasting, which occur during critical illness and contribute to prolonged functional impairment [25]. Beyond loss of muscle mass, persistent alterations in muscle metabolism, mitochondrial bioenergetics, and the muscle transcriptome have been described in survivors [26–28]. Critical illness also provokes a marked systemic inflammatory and endothelial response; in a subset of sepsis survivors, abnormalities in inflammatory and immunosuppressive biomarkers persist for months and have been linked to readmission and late mortality, although their persistence and clinical relevance are heterogeneous across cohorts [23, 24]. Emerging evidence further implicates epigenetic changes, including altered DNA methylation, as potential substrates for sustained dysfunction [29–31].

Skeletal-muscle pathobiology

ICUAW is the hallmark of physical PICS and reflects the combined effects of critical illness myopathy, polyneuropathy, and disuse atrophy [32]. Enhanced proteolysis through the ubiquitin–proteasome and autophagy pathways, suppressed protein synthesis, oxidative stress, mitochondrial dysfunction, and impaired excitation–contraction coupling together drive muscle loss [25, 33, 34]. Persistent deficits in muscle quality—fibrosis, altered fibre composition, and impaired regenerative capacity—may remain even after muscle mass is restored, producing lasting weakness and fatigue, and have been associated with altered DNA methylation and gene expression detectable years after ICU admission [35].

Neuroinflammation and blood–brain-barrier injury

Systemic inflammation can compromise the integrity of the blood–brain barrier, allowing peripheral mediators to promote central neuroinflammation [36–38]. Activated microglia and disrupted neuronal networks contribute to cognitive dysfunction and mood disturbance, while hypoxaemia, impaired cerebral autoregulation, and microvascular injury exacerbate neuronal vulnerability [36–39]. Structural imaging in survivors frequently reveals white-matter abnormalities associated with long-term cognitive deficits [14, 31, 40, 41].

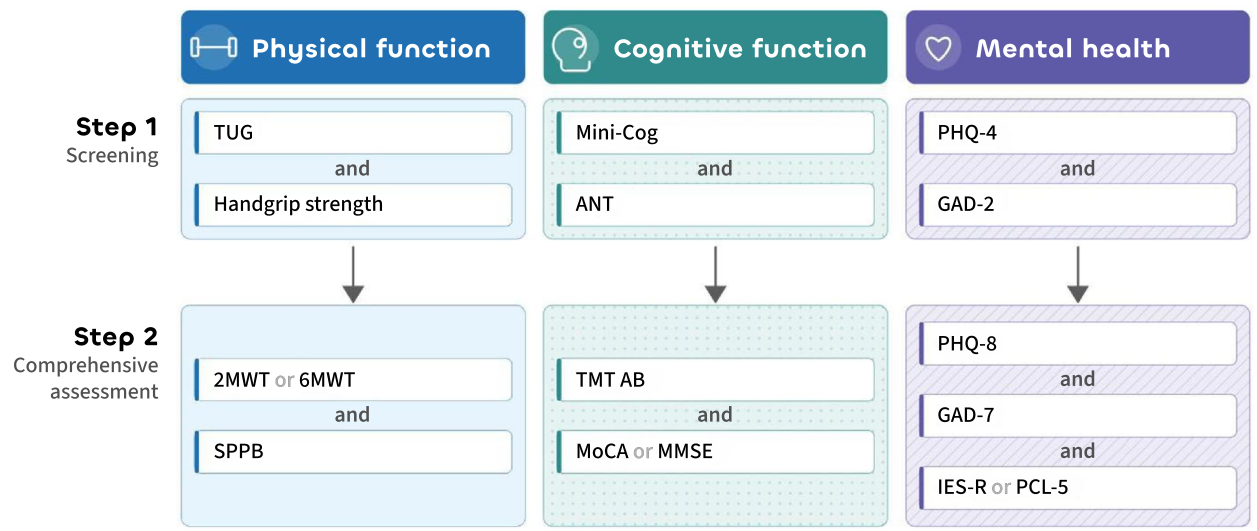

Fig. 1 Recommended two-step assessment of the three core domains of PICS based on Spies et al. [51]. In Step 1 (screening), all survivors undergo brief, low-burden tests: physical function with the TUG and handgrip strength; cognition with the Mini-Cog and the ANT; and mental health with the PHQ-4 and the GAD-2. We recommend screening for PICS at 3 months after discharge, while screening for risk of PICS can occur at ICU discharge (transition to the ward) and/or at hospital discharge. In Step 2 (comprehensive assessment), any domain that screens positive is evaluated in more detail, about 3 months after hospital discharge with reassessment at 6 and 12 months: physical function with the 2MWT or 6MWT and the SPPB; cognition with the TMT A/B and either the MoCA or the MMSE; and mental health with the PHQ-8, the GAD-7, and either the IES-R or the PCL-5. 2MWT, 2-min walk test; 6MWT, 6-min walk test; ANT, animal naming test; DSM-5, Diagnostic and Statistical Manual of Mental Disorders; GAD-2, Generalized Anxiety Disorder 2-item scale; GAD-7, Generalized Anxiety Disorder 7-item scale; ICU, intensive care unit; IES-R, Impact of Event Scale-Revised; MMSE, Mini-Mental State Examination; MoCA, Montreal Cognitive Assessment; PCL-5, post-traumatic stress disorder checklist for DSM-5; PHQ-4, Patient Health Questionnaire 4-item; PHQ-8, Patient Health Questionnaire 8-item; PICS, post-intensive care syndrome; PTSD, post-traumatic stress disorder; SPPB, Short Physical Performance Battery; TMT A/B, Trail Making Test parts A and B; TUG, Timed Up-and-Go.

Neuroendocrine and microvascular contributions

Critical illness disrupts the hypothalamic–pituitary–adrenal, thyroid, and gonadal hormonal axes; persistent abnormalities in these pathways may contribute to catabolism, metabolic dysregulation, mood disorders, and impaired recovery [42–44].

Endothelial dysfunction, microvascular thrombosis, and capillary leak are well-established features of acute illness, and fibroproliferative responses—especially in the lung—have been associated with later structural and functional decline [45–48]; however, direct evidence that persistent microvascular dysfunction causes PICS remains limited [23, 46]. These processes are probably modulated by pre-existing vulnerabilities such as age, comorbidity, and frailty [22, 49]. How acute vascular and repair pathways translate into long-term dysfunction is a key focus for future research and may identify targets for prevention and recovery.

Assessment and outcome measurement

The outcome domains recommended for measurement are physical function, cognitive function, and mental health [50]. Additional domains, such as HRQoL, sleep, dysphagia, pain, and fatigue, are sometimes investigated but are typically not part of the core domains. Family health and functioning may affect ICU survivors but are less consistently measured outside the research context.

A Core Outcome Set to assess for PICS is not currently available. We suggest a two-step process (Fig. 1) that may increase the identification of patients with PICS: an initial brief screening (e.g., PHQ-4, MiniCog, Timed Up-and-Go) followed by a more comprehensive evaluation (e.g., 6-Minute-Walk-Test) if impairments are identified in at least one domain [51]. This pragmatic pathway reflects expert consensus rather than validated diagnostic criteria (low-certainty evidence).

Physical function and ICUAW

ICUAW is the most prevalent physical component of PICS [52]. It is typically symmetric and generalised, may involve peripheral and respiratory muscles (including the diaphragm) while sparing facial and ocular muscles, and relates to the length of ICU stay and the duration of mechanical ventilation [35]. A range of diagnostic tools is available, including clinical examination, the Medical Research Council Sum Score (MRCss), handgrip dynamometry, ultrasound, electrophysiology, and muscle biopsy, each with distinct strengths and limitations; the optimal ultrasound definition of ICUAW remains unsettled [53, 54]. At follow-up, the MRCss, the (1-min) sit-to-stand test, and the six-minute walk test (6-MWT) are most often used.

Reduced exercise capacity is a frequent and disabling consequence of critical illness that often limits activities of daily living; abnormal aerobic capacity has been documented in up to one-third of survivors even five years after ICU admission [55]. The 6-MWT and the (1-min) sit-to-stand test are feasible, submaximal surrogates of functional capacity, whereas cardiopulmonary exercise testing (CPET) remains the reference standard to disentangle muscular, cardiac, and pulmonary contributions and to inform targeted (e.g., cardiac or pulmonary) rehabilitation. The routine use of CPET to characterise recovery trajectories and to tailor rehabilitation is a promising area for future research.

Cognitive function

Long-term cognitive impairment is common, and its pathophysiology is incompletely understood. Improvement is greatest during the first 6–12 months after discharge, although deficits may persist for years [14]. Episodes of critical illness have been associated with subsequent long-term cognitive decline, although whether ICU admission confers additional cognitive risk beyond acute hospitalisation itself remains uncertain [55, 56]. The Montreal Cognitive Assessment (MoCA) and the Mini-Mental State Examination (MMSE) are widely used for screening and orientation.

Mental health

Anxiety, depression, and PTSD frequently overlap and may persist for months or longer. Anxiety affects about one-third of survivors, depressive symptoms are similarly common and often somatic, and PTSD occurs in roughly one in five, particularly after prior psychopathology or frightening and delusional ICU memories [57]. The Hospital Anxiety and Depression Scale (HADS) and the Impact of Event Scale-Revised (IES-R) are the instruments most often used; the PTSD Checklist for DSM-5 (PCL-5) is increasingly applied as a DSM-5-aligned alternative for screening post-traumatic stress symptoms [58].

Other aspects

Given the multidimensional and often persistent consequences of critical illness, HRQoL should be assessed during follow-up. The Short Form-36 (SF-36) covers eight health domains, whereas the EQ-5D-5L is shorter, freely available and incorporates a visual analogue scale that supports estimation of quality-adjusted life-years.

Beyond HRQoL, several further domains are clinically relevant but inconsistently captured. Fatigue is among the most prevalent and disabling symptoms of PICS, affecting more than half of survivors during the first year and beyond, and can be quantified with the Fatigue Severity Scale (FSS) or the Functional Assessment of Chronic Illness Therapy–Fatigue (FACIT-F) [59]. Swallowing disorders (post-extubation dysphagia) are common after mechanical ventilation, frequently persist to hospital discharge, and are independently associated with aspiration, pneumonia, and mortality, yet are rarely screened for systematically [60]. Persistent pain is reported by roughly one-third to one-half of survivors at 3–12 months and warrants structured assessment and management [61].

Sleep disturbance is likewise common, persisting in a substantial proportion of survivors well beyond discharge, contributing to fatigue, impaired daytime functioning, and reduced quality of life [62]; it can be screened for with the Pittsburgh Sleep Quality Index, yet is seldom assessed systematically.

Return to work is a further patient-centred outcome that integrates physical, cognitive, and psychological recovery: roughly two-thirds of previously employed survivors remain jobless at 3 months and about 40% at 12 months, with reduced hours or loss of income in many cases [63].

Timing and standardisation challenges

The timing of assessment should balance early patient benefit against later diagnostic clarity. We agree that early identification of at-risk patients is essential. The Society of Critical Care Medicine consensus recommends assessing ICU survivors across the continuum of care: at ICU admission (focusing on pre-existing impairments), at transfer to the normal ward, and after hospital discharge [64]. An early assessment 2–4 weeks after hospital discharge is often difficult, because, depending on the health care system, those patients may still be in a rehabilitation facility. Furthermore, we should allow patients to convalesce after their critical illness before we add another diagnosis.

As with other chronic conditions, we suggest a comprehensive multidisciplinary evaluation approximately 3 months after discharge, with reassessment at 6 and 12 months as clinically indicated [15] (Table 1). This timing reflects expert consensus rather than comparative trial evidence (low-certainty evidence; Table 2).

Limitations

Although standardised protocols for outcome-measurement instruments exist [51], implementation remains low, and the measurement properties of the instruments or assessment time points used vary significantly. This circumstance makes it difficult to compare study results, particularly when evaluating the effectiveness of targeted

Table 1 Suggested time points for assessments

PICS domain	ICU discharge	3 months	6 months	12 months
Physical function	x	x	x	x
Cognitive function		x	x	x
Mental health		x	x	x
Health-related quality of life		x	x	x
Pain		x	x	x
Fatigue		x	x	x
Sleep		x	x	x
Swallowing (dysphagia)	x			
Return to work/social participation			x	x
Family (PICS-F)	x	x	x	x

interventions on outcome-measurement instruments. Although greater standardisation would be desirable, several challenges remain. Feasibility must be considered, considering the varying personnel and financial resources available. In addition, instruments assessing health-related quality of life and mental health require validation and cultural adaptation to participants' backgrounds, which may conflict with the concept of a fully standardised approach. Furthermore, certain patient groups (e.g., neurocritical care populations) have been underrepresented in previous research, further complicating efforts towards standardisation.

Some instruments require patients to attend in-person appointments, which can be particularly challenging for patients due to PICS-related impairments, especially if they live in remote areas. In such cases, telemedicine may facilitate initial consultations and basic screening [65, 66]. However, the outcome-measurement instruments must be validated and, if necessary, adapted for this purpose. We, however, suggest testing telemedical concepts to improve equitable access to care. Current evidence for this rests on small trials and observational data and is of low certainty (Table 2).

Finally, comprehensive expertise and structured opportunities for evaluation and therapy are not yet consistently available across Europe. While some countries (e.g., The Netherlands, Portugal, England) have integrated intensive care follow-up programmes into public health systems and routine clinical practice, others (e.g., Germany, Switzerland, and Italy) rely on isolated centres, and several countries remain at an early stage of development [67]. We suggest the strategic implementation of integrated intensive care follow-up programmes at the health system level. This recommendation rests on survey and observational data together with expert consensus rather than on comparative trials (low-certainty evidence).

Interventions across the care continuum

Prevention during ICU care: the ABCDEF bundle

The ABCDEF (A–F) bundle—pain assessment and management; both spontaneous awakening and breathing trials; choice of analgesia and sedation; delirium assessment, prevention, and management; early mobilisation; and family engagement—provides a pragmatic prevention package that targets the most prevalent, modifiable ICU exposures [68]. In adult ICUs, higher bundle performance is consistently associated with less delirium, shorter mechanical ventilation, reduced ICU and hospital length of stay (LOS), and a higher likelihood of discharge home [68–71]; effects on mortality are inconsistent [68, 70, 72, 73], and long-term functional outcomes remain insufficiently studied [74–76]. The 2025 focused update of the PADIS guidance reinforces these mechanisms, emphasising light sedation, a more purposeful use of sedatives, delirium prevention, and enhanced mobilisation or rehabilitation [77, 78].

From A–F to A–I

The A–F framework has recently been extended to an A–I bundle, adding elements intended to strengthen human-centred care: gaining insight into patient needs (G), delivering holistic care within a more home-like environment (H), and reconsidering ICU design (I) [79]. Proponents argue that these additions could further improve communication with families and the provision of written information; the concept is emerging and not yet supported by outcome data.

Early mobilisation: dose, timing, safety, and team

Although a uniform consensus is lacking, we propose using early mobilisation, defined as mobilisation within 72 h of ICU admission, including both passive and active components [80]. This threshold is pragmatic: short-term benefits of early mobilisation are supported by

Table 2 Strength of the evidence underpinning the principal recommendations across the recovery continuum

Recommendation/intervention	Predominant evidence (study design)	Consistency of findings	Main uncertainties	Evidence strength—descriptive
ABCDEF (A–F) bundle (ICU prevention)	Large observational cohorts; RCTs of components [68, 73, 74]	Consistent for delirium, ventilation, length of stay; mortality inconsistent	Long-term and functional outcomes	Moderate
Light/minimal sedation and delirium prevention (PADIS)	RCTs; guideline consensus [72, 77, 81]	Largely consistent	Long-term cognition	Moderate–high
Early mobilisation in the ICU	RCTs; meta-analyses [80, 82–84]	Short-term benefit consistent; long-term conflicting	Optimal dose and timing; possible subgroup harm	Moderate (short-term)
Safety of early mobilisation	RCT and observational safety data [80, 85–87]	Consistent (< 3% adverse events)	Thresholds in the highest-risk patients	Moderate
Structured ICU-to-ward handover and ward continuity	Observational; expert consensus [88–90]	Limited	Effect on long-term outcomes	Low
Post-discharge physical rehabilitation/exercise	RCTs; meta-analyses [91–93]	Aerobic capacity consistent; QoL and function inconsistent	Optimal content, intensity, duration; responders	Low–moderate
Single clinic-centred, intensivist-led multidisciplinary follow-up	One multicentre RCT (harm signal); observational [94–96]	Inconsistent	Which model, for whom; implementation fidelity	Insufficient to recommend a single model
Telemedicine/tele-rehabilitation	Small trials; observational [66, 93, 97]	Preliminary	Validation; equity of access; outcomes	Low
Peer-support programmes	Observational; qualitative [98, 99]	Valued by patients; outcomes unproven	Effect on clinical outcomes	Low
ICU diaries (patient PTSD/PICS-F)	RCTs [100, 101]	Inconsistent/negative for PTSD	Effect on relatives	Low
Nurse-led multicomponent family interventions (PICS-F)	RCTs [102–104]	May improve communication, satisfaction, early PICS-F	Durability; core outcome set lacking	Low–moderate
Two-step screening and 3-month comprehensive assessment	Expert consensus [15, 51, 64]	No core outcome set	Validated criteria; optimal timing	Consensus-based (low)
Risk-prediction models for PICS	Observational derivation/validation [105, 106]	Modest, variable performance	External validation; algorithmic bias	Insufficient for routine use

QoL, quality of life; PADIS, Pain, Agitation/Sedation, Delirium, Immobility, and Sleep Disruption; PICS-F, post-intensive care syndrome–family; PTSD, post-traumatic stress disorder; RCT, randomised-controlled trial randomised trials and meta-analyses, whereas long-term benefit and the optimal dose remain uncertain (Table 2).

Meta-analyses demonstrate short-term benefits of early mobilisation, including reduced mechanical ventilation time, delirium, and ICU LOS and improved physical function at hospital discharge [82, 107, 108]. Long-term evidence is conflicting and appears to depend on the dose delivered and the comparator: trials show no additional benefit when the comparator already includes guideline-recommended mobilisation, but benefit when usual care lacks early mobilisation [83, 109]. No trial has directly compared mobilisation doses—regarded as the highest research priority in this field [110]—a gap now being addressed by the first international study of the ESICM Rehabilitation and PICS Section (ERUPT; NCT06960642).

Early mobilisation is safe when structured safety criteria are applied [86, 87]: adverse-event rates are below 3% and are typically transient and dose-dependent [83, 85]. Safety has also been demonstrated during extracorporeal membrane oxygenation, continuous renal replacement therapy, and vasopressor support [111–113]. Because cohorts differ, some patients may benefit, while others may be harmed by a higher dose, underscoring the need for individualisation [114–116]. Effective mobilisation is inherently interprofessional: physiotherapists and occupational therapists individualise rehabilitation goals and plans, but nurses are central to ensuring daily mobilisation. Additionally, organisational factors—dedicated staff, protocols, and a culture that prioritises mobilisation—are as important as individual clinical decisions [117].

The ward-based (post-ICU) phase

The period immediately after ICU discharge is a high-risk transition. Up to two-thirds of survivors carry significant physical, psychological, and cognitive morbidity; in a UK survey of 25 centres, 98% of patients required ongoing physiotherapy and 70% were at risk of malnutrition [118]. Yet ward-based rehabilitation is frequently fragmented: competing priorities, lower staffing ratios, and variable handovers result in delayed mobilisation, suboptimal nutrition, and inconsistent goal setting [89, 119]. This "post-ICU gap" may erode gains achieved in the ICU [120]. Structured, multidisciplinary and multiprofessional continuity of care is therefore important. It comprises a comprehensive assessment at ICU discharge, explicit rehabilitation goals, coordinated physiotherapy and nutrition, and review of delirium, mood, and medication burden, supported by step-down units, standardised discharge bundles, and particular attention to patients with prolonged stay, marked weight loss, persistent delirium, or pre-existing frailty [81, 88, 90]. Crucially, such assessments only improve outcomes if their findings reach the receiving team: a structured—ideally standardised—handover between ICU and ward staff, covering the rehabilitation plan, mobilisation and nutritional goals, and outstanding risks, should accompany every transfer to prevent the loss of information that drives the post-ICU gap [120].

The post-hospital phase

After hospital discharge, prevention and treatment of PICS require structured, patient-centred, interprofessional approaches, because this is the period in which PICS is formally recognised and persistent disability may be mitigated. Care should be individualised. Multimodal physical rehabilitation—delivered through inpatient, outpatient, community, and home-based models—aims to restore function, strength, endurance, and independence [121]. Nutritional reassessment, including adequate protein intake during anabolic recovery, should accompany exercise-based rehabilitation, and cognitive rehabilitation and psychological therapies may address neuropsychological sequelae [122, 123]. Integrated pathways and collaboration with primary care are essential for continuity [118]. Meta-analyses of post-discharge exercise interventions show a fairly consistent improvement in aerobic capacity—rated high-certainty in one synthesis of 14 randomised trials—but inconsistent effects on health-related quality of life and other functional outcomes [91, 92] and individual trials such as RECOVER found no improvement in physical recovery or quality of life despite greater patient satisfaction [124]. The evidence therefore supports offering individualised, multimodal rehabilitation while acknowledging that its optimal content, intensity, timing, and duration are undefined and that benefit may be limited to specific subgroups (Table 2) [93, 121].

Three components of post-hospital care remain under-delivered even where rehabilitation is offered. The first is medication: psychoactive drugs started in the ICU—sedatives, antipsychotics, and opioids—are frequently carried forward into the community, and structured pharmacist-led review at hospital discharge reduces medication-related harm [125]. The second is treatment, rather than measurement, of the symptom burden described above: pain, fatigue, sleep disturbance, and dysphagia are each potentially modifiable, yet are seldom the target of an explicit therapeutic plan [16]. The third is vocational rehabilitation: given the employment figures cited earlier, structured work-focused support—phased return, employer liaison, and workplace adjustment—is rarely offered and remains largely untested in this population [63]. Responsibility for each should be assigned to a named service at hospital discharge, because all three fall in the gap between critical care, primary care, and community rehabilitation [126].

Peer-support programmes, in which survivors and their families share experiences during or after recovery, are increasingly offered and valued by patients, although their effect on clinical outcomes is unproven [98].

Organising post-ICU recovery services

Planning for post-hospital rehabilitation begins at ICU discharge, where timely identification of patients at risk for PICS enables rehabilitation and follow-up to be tailored according to individual needs. Several risk-prediction models have been developed, but their predictive performance remains modest, and none can yet be recommended for routine clinical use [105]. Pragmatic stratification, therefore, still relies on established risk markers—illness severity, prolonged mechanical ventilation, delirium, pre-existing frailty, and impairments already evident at ICU discharge—and on structured discharge-screening tools, which together can help target finite follow-up resources towards those at greatest need [106].

Post-ICU recovery services range from hospital-based follow-up clinics to structured rehabilitation programmes and telehealth or hybrid models [94, 95, 127, 128]. Clinics provide multidisciplinary assessment but are resource-intensive and may limit access for frail or remote patients; attendance falls with greater travel distance and with markers of severe illness (prolonged ventilation, tracheostomy, facility discharge), suggesting that clinic-based services may inadequately serve the sickest survivors. Telehealth and virtual-reality approaches aim to widen access but face digital barriers, and the evidence remains preliminary [97, 129]. Importantly, a 2024 randomised trial found that a hospital-based, intensivist-led, multidisciplinary consultation model produced worse 1-year outcomes than standard follow-up [96]. Several features temper this important result: the intervention was largely diagnostic and referral-based (a treatment change occurred in fewer than 8% of patients), and adherence was modest (about 58% attended the 3-month consultation), so structured assessment may have identified and labelled new problems without reliably delivering effective treatment. As a complex intervention designed by expert consensus, not pre-tested or co-designed with patients and without a process evaluation, it remains unclear whether the signal reflects an ineffective concept, incomplete implementation, or genuine harm [130, 131]. These findings argue not against survivorship care itself, but against assuming that a single, clinic-centred, intensivist-led model suits every survivor; they underline the need for theory-driven, patient-centred programmes that match identified needs to effective, adequately resourced treatment and are rigorously evaluated before scale-up.

International provision varies widely, reflecting differences in health policy, reimbursement, and workforce [132, 133]. Reported coverage ranges from high in parts of Europe (for example, the Netherlands, Norway, and Denmark, and nurse-led services in the United Kingdom) to very limited dedicated follow-up elsewhere (for example, Australia), with intermediate or heterogeneous provision in the United States, Switzerland, and Portugal (Fig. 2).

The absence of a dedicated International Classification of Diseases (ICD) code for PICS remains a barrier to consistent coding, reimbursement, and sustainable staffing; a national code has recently been approved in Germany, but a universally valid WHO code is needed.

Sex- and gender-sensitive follow-up care

Sex and gender may influence the development, recognition, and management of PICS and PICS-F, but this area remains underexplored. Existing critical care literature suggests sex- and gender-related differences in ICU access, treatment intensity, outcomes, psychological morbidity, health-seeking behaviour, social support, caregiving roles, and rehabilitation needs [134–136]. These considerations may also apply to people with diverse gender identities and sexual orientations, who may face additional barriers to culturally safe care and family-centred support. At present, evidence is insufficient to recommend specific gender-tailored PICS follow-up pathways [134, 137]. Nevertheless, future research should evaluate whether prevention, rehabilitation, education, family support, and post-ICU follow-up should incorporate sex- and gender-sensitive assessment and intervention strategies [138].

The family dimension: PICS-F

PICS-F refers to adverse mental-health outcomes among relatives—depression, anxiety, PTSD, prolonged grief disorder after bereavement [5, 139–141], and caregiver burden among those whose relative survives—and is estimated to affect 20–60% of family members, depending on the definition and the timing of assessment [142–144]. Risk factors can be grouped as patient-related, family-related, and care-related. Assessment relies on a comprehensive evaluation of mental, social, and physical function using validated instruments, but no core outcome set exists yet [140, 143].

Evidence on prevention and treatment is mixed [103, 145]; however, nurse-led, multicomponent family

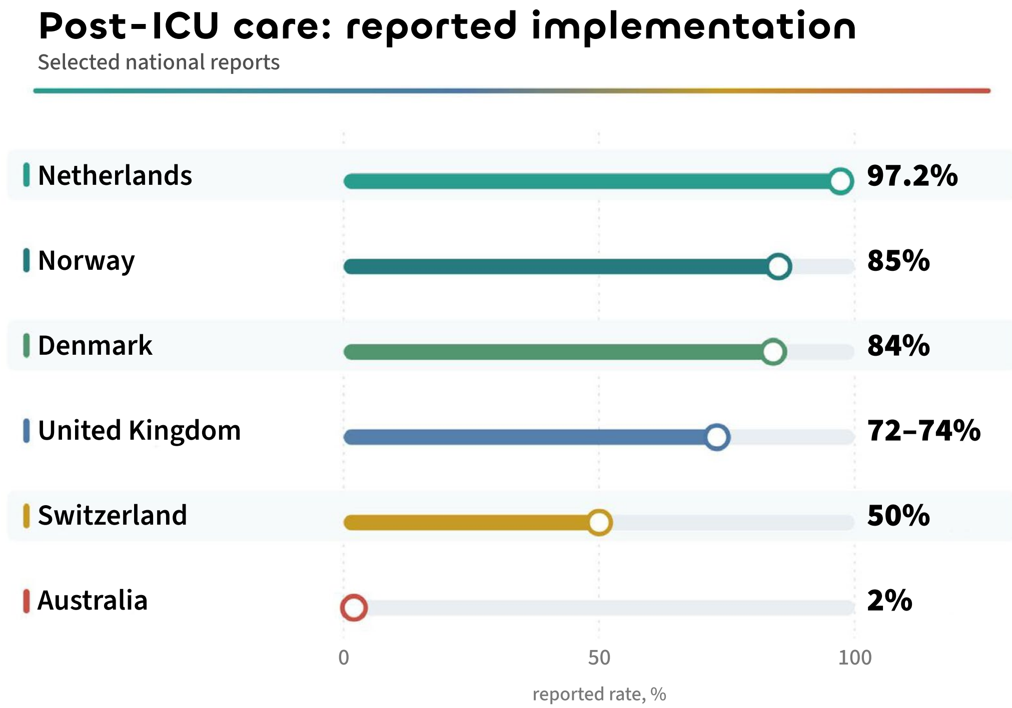

Fig. 2 Post-ICU care implementation in different countries

interventions delivered during and after the ICU stay can improve communication and satisfaction, support shared decision-making, and may reduce PICS-F in the early months [146]. ICU diaries, although widely used and intuitively appealing, have not shown a consistent benefit: a large randomised trial reported no reduction in post-traumatic stress symptoms among mechanically ventilated survivors, and their effect on relatives' psychological outcomes remains unproven [101].

Liberalised family presence, consistent communication, proactive engagement, attention to families' emotional and practical needs, redesign of ICU spaces, and integrated follow-up that extends to relatives are therefore widely advocated and are consistent with current family-centred care guidance [102, 147].

Conceptually, this reflects a shift from regarding patients and relatives as separate individuals towards viewing the family as an interdependent system in which distress, coping, and recovery are shared; dyadic interventions that target survivor and caregiver together are an emerging, theory-driven approach to PICS and PICS-F [148, 149].

Another underexplored aspect of family recovery concerns minor children of adult ICU patients. Parental critical illness may disrupt family functioning and place children at risk of psychological distress, altered family roles, and adverse developmental or educational consequences. Despite these potential impacts, the experiences and support needs of these children remain largely unknown, highlighting an important priority for future research and the development of family-centred rehabilitation strategies.

Although this review focuses on adults, paediatric post-intensive care syndrome (PICS-p) deserves specific acknowledgement. Children surviving paediatric intensive care may experience new or worsened physical, cognitive, emotional, and social impairments after critical illness, but these sequelae must be interpreted against the background of growth, neurodevelopment, schooling, and family development. In addition to weakness, cognitive dysfunction, anxiety, or post-traumatic stress symptoms, PICS-p may include developmental delay, school absenteeism or academic difficulties, reduced peer interaction, impaired social participation, and altered family functioning. The PICS-p framework also emphasises the interdependence between child and family outcomes, including sibling and parental psychological distress, caregiver burden, and disruption of family routines. Consequently, paediatric survivorship care requires age-appropriate, developmentally informed, family-centred assessment and follow-up. Because mechanisms, outcome measures, and rehabilitation pathways differ in adults, PICS-p should be addressed in dedicated paediatric guidance and research rather than simply extrapolated from adult PICS [150, 151].

From individuals to family systems

An emerging body of work suggests that critical illness affects not only individual survivors and relatives, but also the family as a dynamic biopsychosocial system [5, 140]. Recovery may be shaped by reciprocal interactions between patients and family members, including shared psychological distress, caregiver burden, changes in family roles and identity, financial strain, and altered social participation [148, 149]. Family functioning may therefore influence, and be influenced by, patient recovery trajectories and relatives' mental health. This perspective extends the concept of PICS-F beyond parallel individual outcomes and supports the development of assessment strategies, educational interventions, follow-up programmes, and research designs that consider patient–family dyads and wider family systems [102, 104, 152]. Future studies should clarify how family-level processes mediate recovery and whether family-systems interventions improve outcomes for both survivors and relatives [153].

Education, training, and culture change

Embedding rehabilitation into routine practice depends on education, training, and cultural change [16, 154]. ICU professionals require competencies in early, individualised rehabilitation, including safe mobilisation of mechanically ventilated patients, basic functional and delirium assessment, recognition of PICS and PICS-F, family partnership, collaborative goal setting, and the use of structured tools at ICU discharge [51, 68, 81, 126, 152, 155, 156]; these are best acquired through formal curricula, simulation, and bedside mentoring [4, 157]. Interprofessional education fosters a shared understanding of PICS and PICS-F and has been shown to improve knowledge of professional roles and confidence in managing survivors [68, 158]. Sustained culture change requires visible leadership, local champions, integration of rehabilitation into institutional priorities, and reframing of success beyond survival, supported by audit and feedback and by the inclusion of rehabilitation metrics—mobilisation milestones, delirium prevalence, and discharge functional status—in routine quality monitoring [68, 159, 160]. Consequently, institutions should support interprofessional education activities that foster a culture of mutual respect, psychological safety, and shared responsibility for the long-term outcomes of ICU survivors and their families [68, 152, 159, 160].

Health-system and policy considerations

PICS and PICS-F impose a considerable burden on patients, families, and health systems [4, 5, 161]. It affects a large proportion of survivors and their families, elevates healthcare costs, and is associated with substantial productivity losses, increased readmissions, long-term care needs, and workforce disengagement [16, 161]. Prevention and rehabilitation align with value-based healthcare by prioritising patient- and family-centred outcomes such as quality of life and functional independence rather than volume of care, and multidisciplinary interventions—early mobilisation, delirium prevention, and ICU diaries—may reduce long-term sequelae while lowering costs through shorter stays and fewer readmissions [16, 50, 162, 163]. Realising these benefits will require political advocacy, financing mechanisms that incentivise evidence-based prevention and post-ICU rehabilitation, integration across academic and non-academic providers, and equitable coverage for all survivors.

Future research priorities

Across the continuum, the evidence base remains limited and heterogeneous. Despite growing recognition of PICS, several important controversies remain. There is still no universally accepted diagnostic framework, considerable heterogeneity exists in outcome measures and timing of assessment, and evidence supporting specific rehabilitation interventions remains limited. Furthermore, the multifactorial origin of long-term impairments complicates attribution to critical illness itself. These methodological challenges hinder comparison across studies and limit translation of evidence into routine clinical practice. Taken together, the evidence supports viewing PICS not as a static syndrome confined to the post-discharge period, but as a dynamic recovery process that evolves across the continuum of critical illness and is influenced by interactions between patient characteristics, ICU-related factors, rehabilitation, and family context.

Priorities for future research include: harmonised definition and diagnostic criteria for PICS and PICS-F; longitudinal phenotyping of recovery trajectories, particularly beyond the first year; the optimal dose and timing of rehabilitation; rigorous, head-to-head evaluation of follow-up models and of which survivors benefit from which model; effective family interventions; mechanistic studies—including biomarker and epigenetic work—to identify targets for prevention and recovery; validation of telemedicine and other approaches that improve equity of access; and the establishment of a universal ICD code. Further priorities include the influence of sex and gender on PICS trajectories and the corresponding tailoring of prevention, rehabilitation, and follow-up [134].

Additionally, future work should address the responsible, bias-aware use of artificial intelligence for risk prediction, the role of cultural, religious, and spiritual context in recovery, family-systems and dyadic approaches to PICS and PICS-F, and PICS-p alongside the needs of the minor children of adult ICU patients.

Artificial intelligence

Artificial intelligence and machine-learning approaches may improve the prediction of recovery trajectories, identification of patients at high risk for PICS, and individualisation of rehabilitation strategies [105]. However, predictive models are inherently dependent on the quality, completeness, and representativeness of the datasets on which they are trained. Systematic biases related to sex, gender, age, ethnicity, socioeconomic status, healthcare access, or other determinants of health may inadvertently be propagated into algorithmic predictions and clinical decision-making [164, 165]. Future work should therefore prioritise transparent model development, rigorous external validation, fairness assessment across diverse populations, and prospective evaluation before AI-supported tools are implemented in routine post-ICU care [166].

Cultural and spiritual dimensions

Cultural, religious, and spiritual beliefs may influence how survivors and families interpret critical illness, recovery, disability, and rehabilitation [167, 168]. In many Western healthcare systems, survivorship care often emphasises patient autonomy, active participation, and individual responsibility for recovery [147, 169]. In other cultural or religious contexts, illness and recovery may be understood more strongly in relation to family roles, community obligations, spiritual meaning, or transcendent forces [170, 171]. These perspectives may affect awareness of PICS, expectations of recovery, engagement with rehabilitation, acceptance of psychological support, and responses to educational interventions. Future work should therefore examine how culturally responsive, spiritually sensitive, and family-centred approaches can improve communication, trust, access, and adherence across diverse populations [147, 152].

Conclusion

PICS, together with PICS-F, is a major and increasingly recognised consequence of critical illness that affects patients, families, and professionals across the recovery continuum. Despite growing awareness, prevention, assessment, and management, it remains insufficiently defined, and the evidence base remains limited. This narrative review complements the ESICM position paper by synthesising the supporting evidence and by defining the research priorities needed to advance equitable, evidence-based survivorship care.

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Data availability

No dataset was generated, so data sharing ist not applicable.

Declarations

Conflicts of interest

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Data sharing
No datasets were generated.

Ethics
Not applicable.

Generative AI technology
Grammarly (Grammarly, Inc.) was used for English-language correction. ChatGPT (OpenAI, GPT-5) and Claude (Anthropic PBC, Claude Opus 4 and 5) were used additionally to support literature searching and reference identification, revise passages, and check internal consistency. All AI outputs were verified against the primary sources and edited by the authors, who take full responsibility for the content of this manuscript, including the accuracy of all references and claims.

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References

1. Poole AP, Chaba A, Bellomo R, Bailey M, Deane A, Delaney A, Eastwood G, Haines K, Hammond N, Hensman T, Higgins A, Jones D, McQuilten Z, Mendis C, Serpa Neto A, Pilcher D, Saxena M, Shekar K, Thompson K, Young PJ, Litton E, Udy AA, National Critical Care Research Platform I (2025) Mortality trends for sepsis and septic shock among critically ill adults in Australia and New Zealand. Intensive Care Med 51:2318–2328. https://doi.org/10.1007/s00134-025-08162-y
2. Hermann M, Karner V, Schaller SJ (2026) Update on long-term physical disability after critical illness: the burden of post-intensive care syndrome. Intensive Care Med. https://doi.org/10.1007/s00134-026-08355-z
3. Herridge MS, Azoulay E (2023) Outcomes after critical illness. N Engl J Med 388:913–924. https://doi.org/10.1056/NEJMra2104669
4. Needham DM, Davidson J, Cohen H, Hopkins RO, Weinert C, Wunsch H, Zawistowski C, Bemis-Dougherty A, Berney SC, Bienvenu OJ, Brady SL, Brodsky MB, Denehy L, Elliott D, Flatley C, Harabin AL, Jones C, Louis D, Meltzer W, Muldoon SR, Palmer JB, Perme C, Robinson M, Schmidt DM, Scruth E, Spill GR, Storey CP, Render M, Votto J, Harvey MA (2012) Improving long-term outcomes after discharge from intensive care unit: report from a stakeholders' conference. Crit Care Med 40:502–509. https://doi.org/10.1097/CCM.0b013e318232da75
5. Shirasaki K, Hifumi T, Nakanishi N, Nosaka N, Miyamoto K, Komachi MH, Haruna J, Inoue S, Otani N (2024) Postintensive care syndrome family: a comprehensive review. Acute Med Surg 11:e939. https://doi.org/10.1002/ams2.939
6. Iwashyna TJ, Ely EW, Smith DM, Langa KM (2010) Long-term cognitive impairment and functional disability among survivors of severe sepsis. JAMA 304:1787–1794. https://doi.org/10.1001/jama.2010.1553
7. Butcher BW (2026) Post-intensive care syndrome. JAMA 335:542–543. https://doi.org/10.1001/jama.2025.23666
8. Girard TD, Jackson JC, Pandharipande PP, Pun BT, Thompson JL, Shintani AK, Gordon SM, Canonico AE, Dittus RS, Bernard GR, Ely EW (2010) Delirium as a predictor of long-term cognitive impairment in survivors of critical illness. Crit Care Med 38:1513–1520. https://doi.org/10.1097/CCM.0b013e3181e47be1
9. Baethge C, Goldbeck-Wood S, Mertens S (2019) SANRA-a scale for the quality assessment of narrative review articles. Res Integr Peer Rev 4:5. https://doi.org/10.1186/s41073-019-0064-8
10. Sukhera J (2022) Narrative reviews: flexible, rigorous, and practical. J Grad Med Educ 14:414–417. https://doi.org/10.4300/JGME-D-22-00480.1
11. Berkman ND, Lohr KN, Ansari MT, Balk EM, Kane R, McDonagh M, Morton SC, Viswanathan M, Bass EB, Butler M, Gartlehner G, Hartling L, McPheeters M, Morgan LC, Reston J, Sista P, Whitlock E, Chang S (2015) Grading the strength of a body of evidence when assessing health care interventions: an EPC update. J Clin Epidemiol 68:1312–1324. https://doi.org/10.1016/j.jclinepi.2014.11.023
12. Campbell M, McKenzie JE, Sowden A, Katikireddi SV, Brennan SE, Ellis S, Hartmann-Boyce J, Ryan R, Shepperd S, Thomas J, Welch V, Thomson H (2020) Synthesis without meta-analysis (SWiM) in systematic reviews: reporting guideline. BMJ 368:l6890. https://doi.org/10.1136/bmj.l6890
13. Greenhalgh T, Thorne S, Malterud K (2018) Time to challenge the spurious hierarchy of systematic over narrative reviews? Eur J Clin Investig 48:e12931. https://doi.org/10.1111/eci.12931
14. Pandharipande PP, Girard TD, Jackson JC, Morandi A, Thompson JL, Pun BT, Brummel NE, Hughes CG, Vasilevskis EE, Shintani AK, Moons KG, Geevarghese SK, Canonico A, Hopkins RO, Bernard GR, Dittus RS, Ely EW, Investigators B-IS (2013) Long-term cognitive impairment after critical illness. N Engl J Med 369:1306–1316. https://doi.org/10.1056/NEJMoa1301372
15. Tanaka K, Nakanishi N, Liu K, Miyamoto K, Kawauchi A, Okamura M, Katayama S, Iida Y, Kawai Y, Hatakeyama J, Hifumi T, Unoki T, Kawakami D, Amaya F, Obata K, Sumita H, Morisawa T, Tsuboi N, Kozu R, Takaki S, Haruna J, Ota K, Fujinami Y, Nosaka N, Shirasaki K, Inoue S, Nishida O, Nakamura K (2025) Optimal timing for assessing post-intensive care syndrome in clinical research: a scoping review and expert survey. J Intensive Care 13:45. https://doi.org/10.1186/s40560-025-00817-8
16. Renner C, Jeitziner MM, Albert M, Brinkmann S, Diserens K, Dzialowski I, Heidler MD, Luck M, Nusser-Muller-Busch R, Sandor PS, Schafer A, Scheffler B, Wallesch C, Zimmermann G, Nydahl P (2023) Guideline on multimodal rehabilitation for patients with post-intensive care syndrome. Crit Care 27:301. https://doi.org/10.1186/s13054-023-04569-5
17. Flaws D, Patterson S, Fraser J, Tronstad O, Scott JG (2021) Reconceptualizing post-intensive care syndrome: do we need to unpick our PICS? Nurs Crit Care 26:67–69. https://doi.org/10.1111/nicc.12545

18. Geense WW, Zegers M, Peters MAA, Ewalds E, Simons KS, Vermeulen H, van der Hoeven JG, van den Boogaard M (2021) New physical, mental, and cognitive problems 1 year after ICU admission: a prospective multicenter study. Am J Respir Crit Care Med 203:1512–1521. https://doi.org/10.1164/rccm.202009-3381OC
19. Huang L, Li X, Gu X, Zhang H, Ren L, Guo L, Liu M, Wang Y, Cui D, Wang Y, Zhang X, Shang L, Zhong J, Wang X, Wang J, Cao B (2022) Health outcomes in people 2 years after surviving hospitalisation with COVID-19: a longitudinal cohort study. Lancet Respir Med 10:863–876. https://doi.org/10.1016/S2213-2600(22)00126-6
20. Lim EJ, Son CG (2020) Review of case definitions for myalgic encephalomyelitis/chronic fatigue syndrome (ME/CFS). J Transl Med 18:289. https://doi.org/10.1186/s12967-020-02455-0
21. Voiriot G, Oualha M, Pierre A, Salmon-Gandonniere C, Gaudet A, Jouan Y, Kallel H, Radermacher P, Vodovar D, Sarton B, Stiel L, Brechot N, Preau S, Joffre J, la CRTdIS (2022) Chronic critical illness and post-intensive care syndrome: from pathophysiology to clinical challenges. Ann Intensive Care 12:58. https://doi.org/10.1186/s13613-022-01038-0
22. Brummel NE, Bell SP, Girard TD, Pandharipande PP, Jackson JC, Morandi A, Thompson JL, Chandrasekhar R, Bernard GR, Dittus RS, Gill TM, Ely EW (2017) Frailty and subsequent disability and mortality among patients with critical illness. Am J Respir Crit Care Med 196:64–72. https://doi.org/10.1164/rccm.201605-0939OC
23. Yende S, Kellum JA, Talisa VB, Peck Palmer OM, Chang CH, Filbin MR, Shapiro NI, Hou PC, Venkat A, LoVecchio F, Hawkins K, Crouser ED, Newman AB, Angus DC (2019) Long-term host immune response trajectories among hospitalized patients with sepsis. JAMA Netw Open 2:e198686. https://doi.org/10.1001/jamanetworkopen.2019.8686
24. Zorio V, Venet F, Delwarde B, Floccard B, Marcotte G, Textoris J, Monneret G, Rimmele T (2017) Assessment of sepsis-induced immunosuppression at ICU discharge and 6 months after ICU discharge. Ann Intensive Care 7:80. https://doi.org/10.1186/s13613-017-0304-3
25. Puthucheary ZA, Rawal J, McPhail M, Connolly B, Ratnayake G, Chan P, Hopkinson NS, Phadke R, Dew T, Sidhu PS, Velloso C, Seymour J, Agley CC, Selby A, Limb M, Edwards LM, Smith K, Rowlerson A, Rennie MJ, Moxham J, Harridge SD, Hart N, Montgomery HE (2013) Acute skeletal muscle wasting in critical illness. JAMA 310:1591–1600. https://doi.org/10.1001/jama.2013.278481
26. Owen AM, Patel SP, Smith JD, Balasuriya BK, Mori SF, Hawk GS, Stromberg AJ, Kuriyama N, Kaneki M, Rabchevsky AG, Butterfield TA, Esser KA, Peterson CA, Starr ME, Saito H (2019) Chronic muscle weakness and mitochondrial dysfunction in the absence of sustained atrophy in a preclinical sepsis model. Elife. https://doi.org/10.7554/eLife.49920
27. Jameson TSO, Caldow MK, Stephens F, Denehy L, Lynch GS, Koopman R, Krajcova A, Urban T, Berney S, Duska F, Puthucheary Z (2023) Inflammation and altered metabolism impede efficacy of functional electrical stimulation in critically ill patients. Crit Care 27:428. https://doi.org/10.1186/s13054-023-04664-7
28. Uzun Ayar C, Guiza F, Derese I, Pauwels L, Vander Perre S, Pintelon I, Casaer M, Van Aerde N, Hermans G, Derde S, Kreiss L, Van den Berghe G, Vanhorebeek I (2025) Altered muscle transcriptome as molecular basis of long-term muscle weakness in survivors from critical illness. Intensive Care Med 51:1062–1077. https://doi.org/10.1007/s00134-025-07949-3
29. Van Dyck L, Guiza F, Derese I, Pauwels L, Casaer MP, Hermans G, Wouters PJ, Van den Berghe G, Vanhorebeek I (2022) DNA methylation alterations in muscle of critically ill patients. J Cachexia Sarcopenia Muscle 13:1731–1740. https://doi.org/10.1002/jcsm.12970
30. Vanhorebeek I, Coppens G, Guiza F, Derese I, Wouters PJ, Joosten KF, Verbruggen SC, Van den Berghe G (2023) Abnormal DNA methylation within genes of the steroidogenesis pathway two years after paediatric critical illness and association with stunted growth in height further in time. Clin Epigenetics 15:116. https://doi.org/10.1186/s13148-023-01530-9
31. Uzun Ayar C, Guiza F, Derese I, Van den Berghe G, Vanhorebeek I (2026) Association between abnormal DNA methylation and altered transcriptome in muscle five years after critical illness. J Cachexia Sarcopenia Muscle 17:e70170. https://doi.org/10.1002/jcsm.70170
32. Stevens RD, Marshall SA, Cornblath DR, Hoke A, Needham DM, de Jonghe B, Ali NA, Sharshar T (2009) A framework for diagnosing and classifying intensive care unit-acquired weakness. Crit Care Med 37:S299-308. https://doi.org/10.1097/CCM.0b013e3181b6ef67
33. Friedrich O, Reid MB, Van den Berghe G, Vanhorebeek I, Hermans G, Rich MM, Larsson L (2015) The sick and the weak: neuropathies/myopathies in the critically ill. Physiol Rev 95:1025–1109. https://doi.org/10.1152/physrev.00028.2014
34. Larsson L, Li X, Edstrom L, Eriksson LI, Zackrisson H, Argentini C, Schiaffino S (2000) Acute quadriplegia and loss of muscle myosin in patients treated with nondepolarizing neuromuscular blocking agents and corticosteroids: mechanisms at the cellular and molecular levels. Crit Care Med 28:34–45
35. Latronico N, Rasulo FA, Eikermann M, Piva S (2023) Illness weakness, polyneuropathy and myopathy: diagnosis, treatment, and long-term outcomes. Crit Care 27:439. https://doi.org/10.1186/s13054-023-04676-3
36. Gofton TE, Young GB (2012) Sepsis-associated encephalopathy. Nat Rev Neurol 8:557–566. https://doi.org/10.1038/nrneurol.2012.183
37. Heming N, Mazeraud A, Verdonk F, Bozza FA, Chrétien F, Sharshar T (2017) Neuroanatomy of sepsis-associated encephalopathy. Crit Care 21:65. https://doi.org/10.1186/s13054-017-1643-z
38. Widmann CN, Heneka MT (2014) Long-term cerebral consequences of sepsis. Lancet Neurol 13:630–636. https://doi.org/10.1016/S1474-4422(14)70017-1
39. Sharshar T, Annane D, de la Grandmaison GL, Brouland JP, Hopkinson NS, Françoise G (2004) The neuropathology of septic shock. Brain Pathol 14:21–33. https://doi.org/10.1111/j.1750-3639.2004.tb00494.x
40. Morandi A, Rogers BP, Gunther ML, Merkle K, Pandharipande P, Girard TD, Jackson JC, Thompson J, Shintani AK, Geevarghese S, Miller RR, Canonico A, Cannistraci CJ, Gore JC, Ely EW, Hopkins RO, VISIONS Investigation VISuISNS (2012) The relationship between delirium duration, white matter integrity, and cognitive impairment in intensive care unit survivors as determined by diffusion tensor imaging: the VISIONS prospective cohort magnetic resonance imaging study*. Crit Care Med 40:2182–2189. https://doi.org/10.1097/CCM.0b013e318250acdc
41. Guiza F, Vanhorebeek I, Verstraete S, Verlinden I, Derese I, Ingels C, Dulfer K, Verbruggen SC, Garcia Guerra G, Joosten KF, Wouters PJ, Van den Berghe G (2020) Effect of early parenteral nutrition during paediatric critical illness on DNA methylation as a potential mediator of impaired neurocognitive development: a pre-planned secondary analysis of the PEPaNIC international randomised controlled trial. Lancet Respir Med 8:288–303. https://doi.org/10.1016/S2213-2600(20)30046-1
42. Van den Berghe G (2003) Endocrine evaluation of patients with critical illness. Endocrinol Metab Clin N Am 32:385–410. https://doi.org/10.1016/s0889-8529(03)00005-7
43. Van den Berghe G (2016) On the neuroendocrinopathy of critical illness. perspectives for feeding and novel treatments. Am J Respir Crit Care Med 194:1337–1348. https://doi.org/10.1164/rccm.201607-1516CI
44. Vanhorebeek I, Derese I, Gunst J, Wouters PJ, Hermans G, Van den Berghe G (2021) Persisting neuroendocrine abnormalities and their association with physical impairment 5 years after critical illness. Crit Care 25:430. https://doi.org/10.1186/s13054-021-03858-1
45. Aird WC (2003) The role of the endothelium in severe sepsis and multiple organ dysfunction syndrome. Blood 101:3765–3777. https://doi.org/10.1182/blood-2002-06-1887
46. Ince C, Mayeux PR, Nguyen T, Gomez H, Kellum JA, Ospina-Tascón GA, Hernandez G, Murray P, De Backer D, Workgroup AX (2016) The endothelium in sepsis. Shock 45:259–270. https://doi.org/10.1097/SHK.0000000000000473
47. Burnham EL, Janssen WJ, Riches DW, Moss M, Downey GP (2014) The fibroproliferative response in acute respiratory distress syndrome: mechanisms and clinical significance. Eur Respir J 43:276–285. https://doi.org/10.1183/09031936.00196412
48. Burnham EL, Hyzy RC, Paine R 3rd, Coley C 2nd, Kelly AM, Quint LE, Lynch D, Janssen WJ, Moss M, Standiford TJ (2013) Chest CT features are associated with poorer quality of life in acute lung injury survivors. Crit Care Med 41:445–456. https://doi.org/10.1097/CCM.0b013e31826a5062
49. Clegg A, Young J, Iliffe S, Rikkert MO, Rockwood K (2013) Frailty in elderly people. Lancet 381:752–762. https://doi.org/10.1016/S0140-6736(12)62167-9
50. Bornemann-Cimenti H, Lang J, Hammer S, Lang-Illievich K, Labenbacher S, Neuwersch-Sommeregger S, Klivinyi C (2025)

Consensus-based recommendations for assessing post-intensive care syndrome: a systematic review. J Clin Med. https://doi.org/10.3390/jcm14103595
51. Spies CD, Krampe H, Paul N, Denke C, Kiselev J, Piper SK, Kruppa J, Grunow JJ, Steinecke K, Gulmez T, Scholtz K, Rosseau S, Hartog C, Busse R, Caumanns J, Marschall U, Gersch M, Apfelbacher C, Weber-Carstens S, Weiss B (2021) Instruments to measure outcomes of post-intensive care syndrome in outpatient care settings—results of an expert consensus and feasibility field test. J Intensive Care Soc 22:159–174. https://doi.org/10.1177/1751143720923597
52. Klawitter F, Schaller SJ, Sohle M, Reuter DA, Ehler J (2022) Intensive Care Unit-Acquired Weakness: a nationwide survey on diagnostics, monitoring and treatment strategies on German intensive care units. Anaesthesiologie 71:618–625. https://doi.org/10.1007/s00101-022-01089-9
53. Compston A (2010) Aids to the investigation of peripheral nerve injuries. Medical Research Council: Nerve Injuries Research Committee. His Majesty's Stationery Office: 1942; pp. 48 (iii) and 74 figures and 7 diagrams; with aids to the examination of the peripheral nervous system. By Michael O'Brien for the Guarantors of Brain. Saunders Elsevier: 2010; pp. [8] 64 and 94 Figures. Brain 133:2838–2844. http://www.ncbi.nlm.nih.gov/pubmed/20928945
54. Bald A, Daum N, Schaller SJ (2026) Peripheral muscle ultrasound in the ICU: current evidence, limitations, and future directions. Intensive Care Med. https://doi.org/10.1007/s00134-026-08415-4
55. Van Aerde N, Meersseman P, Debaveye Y, Wilmer A, Casaer MP, Gunst J, Wauters J, Wouters PJ, Goetschalckx K, Gosselink R, Van den Berghe G, Hermans G (2021) Aerobic exercise capacity in long-term survivors of critical illness: secondary analysis of the post-EPaNIC follow-up study. Intensive Care Med 47:1462–1471. https://doi.org/10.1007/s00134-021-06541-9
56. Ehlenbach WJ, Hough CL, Crane PK, Haneuse SJ, Carson SS, Curtis JR, Larson EB (2010) Association between acute care and critical illness hospitalization and cognitive function in older adults. JAMA 303:763–770. https://doi.org/10.1001/jama.2010.167
57. Sprung J, Knopman DS, Petersen RC, Mielke MM, Weingarten TN, Vassilaki M, Martin DP, Schulte PJ, Hanson AC, Schroeder DR, Laporta ML, White RJ, Vemuri P, Warner DO (2021) Association of hospitalization with long-term cognitive trajectories in older adults. J Am Geriatr Soc 69:660–668. https://doi.org/10.1111/jgs.16909
58. Teixeira C, Rosa RG, Sganzerla D, Sanchez EC, Robinson CC, Dietrich C, Kochhann R, de Souza D, Rech GS, da RDSR, Schneider D, Boldo R, Sharshar T, Bozza FA, Falavigna M, Friedman G (2021) The burden of mental illness among survivors of critical care-risk factors and impact on quality of life: a multicenter prospective cohort study. Chest 160:157–164. https://doi.org/10.1016/j.chest.2021.02.034
59. Blevins CA, Weathers FW, Davis MT, Witte TK, Domino JL (2015) The Posttraumatic Stress Disorder Checklist for DSM-5 (PCL-5): development and initial psychometric evaluation. J Trauma Stress 28:489–498. https://doi.org/10.1002/jts.22059
60. Morel J, Infantino P, Gergele L, Lapole T, Souron R, Millet GY (2022) Prevalence of self-reported fatigue in intensive care unit survivors 6 months-5 years after discharge. Sci Rep 12:5631. https://doi.org/10.1038/s41598-022-09623-w
61. Zuercher P, Moret CS, Dziewas R, Schefold JC (2019) Dysphagia in the intensive care unit: epidemiology, mechanisms, and clinical management. Crit Care 23:103. https://doi.org/10.1186/s13054-019-2400-2
62. Makinen OJ, Backlund ME, Liisanantti J, Peltomaa M, Karlsson S, Kalliomaki ML (2020) Persistent pain in intensive care survivors: a systematic review. Br J Anaesth 125:149–158. https://doi.org/10.1016/j.bja.2020.04.084
63. Altman MT, Knauert MP, Pisani MA (2017) Sleep disturbance after hospitalization and critical illness: a systematic review. Ann Am Thorac Soc 14:1457–1468. https://doi.org/10.1513/AnnalsATS.201702-148SR
64. Kamdar BB, Suri R, Suchyta MR, Digrande KF, Sherwood KD, Colantuoni E, Dinglas VD, Needham DM, Hopkins RO (2020) Return to work after critical illness: a systematic review and meta-analysis. Thorax 75:17–27. https://doi.org/10.1136/thoraxjnl-2019-213803
65. Mikkelsen ME, Still M, Anderson BJ, Bienvenu OJ, Brodsky MB, Brummel N, Butcher B, Clay AS, Felt H, Ferrante LE, Haines KJ, Harhay MO, Hope AA, Hopkins RO, Hosey M, Hough CTL, Jackson JC, Johnson A, Khan B, Lone NI, MacTavish P, McPeake J, Montgomery-Yates A, Needham DM, Netzer G, Schorr C, Skidmore B, Stollings JL, Umberger R, Andrews A, Iwashyna TJ, Sevin CM (2020) Society of critical care medicine's international consensus conference on prediction and identification of long-term impairments after critical illness. Crit Care Med 48: 1670–1679. https://doi.org/10.1097/CCM.0000000000004586
66. Butcher BW, Eaton TL, Montgomery-Yates AA, Sevin CM (2022) Meeting the challenges of establishing intensive care unit follow-up clinics. Am J Crit Care 31:324–328. https://doi.org/10.4037/ajcc2022987
67. Lai DJ, Liu Z, Johnston E, Dikomitis L, D'Oliveira T, Shergill S (2024) Exploring the effectiveness of eHealth interventions in treating Post Intensive Care Syndrome (PICS) outcomes: a systematic review. Crit Care 28:317. https://doi.org/10.1186/s13054-024-05089-6
68. Schol CMA, Berger E, Rauh SP, Dekker AB, Spronk PE, Bisschops LLA, Brackel M, van Mol MMC, Kiers D (2025) Mapping the landscape of post-intensive care recovery interventions and their barriers: a nationwide cross-sectional survey. J Crit Care 89:155132. https://doi.org/10.1016/j.jcrc.2025.155132
69. Pun BT, Balas MC, Barnes-Daly MA, Thompson JL, Aldrich JM, Barr J, Byrum D, Carson SS, Devlin JW, Engel HJ, Esbrook CL, Hargett KD, Harmon L, Hielsberg C, Jackson JC, Kelly TL, Kumar V, Millner L, Morse A, Perme CS, Posa PJ, Puntillo KA, Schweickert WD, Stollings JL, Tan A, D'Agostino McGowan L, Ely EW (2019) Caring for critically ill patients with the ABCDEF bundle: results of the ICU liberation collaborative in over 15,000 adults. Crit Care Med 47:3–14. https://doi.org/10.1097/CCM.0000000000003482
70. Balas MC, Vasilevskis EE, Olsen KM, Schmid KK, Shostrom V, Cohen MZ, Peitz G, Gannon DE, Sisson J, Sullivan J, Stothert JC, Lazure J, Nuss SL, Jawa RS, Freihaut F, Ely EW, Burke WJ (2014) Effectiveness and safety of the awakening and breathing coordination, delirium monitoring/management, and early exercise/mobility bundle. Crit Care Med 42:1024–1036. https://doi.org/10.1097/CCM.0000000000000129
71. Barnes-Daly MA, Phillips G, Ely EW (2017) Improving hospital survival and reducing brain dysfunction at seven California community hospitals: implementing PAD guidelines via the ABCDEF bundle in 6,064 patients. Crit Care Med 45:171–178. https://doi.org/10.1097/CCM.0000000000002149
72. Hsieh SJ, Otusanya O, Gershengorn HB, Hope AA, Dayton C, Levi D, Garcia M, Prince D, Mills M, Fein D, Colman S, Gong MN (2019) Staged implementation of awakening and breathing, coordination, delirium monitoring and management, and early mobilization bundle improves patient outcomes and reduces hospital costs. Crit Care Med 47:885–893. https://doi.org/10.1097/CCM.0000000000003765
73. Hume NE, Zerfas I, Wong A, Klein-Fedyshin M, Smithburger PL, Buckley MS, Devlin JW, Kane-Gill SL (2024) Clinical impact of the implementation strategies used to apply the 2013 pain, agitation/sedation, delirium or 2018 pain, agitation/sedation, delirium, immobility, sleep disruption guideline recommendations: a systematic review and meta-analysis. Crit Care Med 52:626–636. https://doi.org/10.1097/CCM.0000000000006178
74. Zhang S, Han Y, Xiao Q, Li H, Wu Y (2021) Effectiveness of bundle interventions on ICU delirium: a meta-analysis. Crit Care Med 49:335–346. https://doi.org/10.1097/CCM.0000000000004773
75. Kawakami D, Fujitani S, Koga H, Dote H, Takita M, Takaba A, Hino M, Nakamura M, Irie H, Adachi T, Shibata M, Kataoka J, Korenaga A, Yamashita T, Okazaki T, Okumura M, Tsunemitsu T (2023) Evaluation of the impact of ABCDEF bundle compliance rates on postintensive care syndrome: a secondary analysis study. Crit Care Med 51:1685–1696. https://doi.org/10.1097/CCM.0000000000005980
76. Sosnowski K, Mitchell M, Cooke M, White H, Morrison L, Lin F (2021) Effectiveness of the ABCDEF bundle on delirium, functional outcomes and quality of life in intensive care patients: a study protocol for a randomised controlled trial with embedded process evaluation. BMJ Open 11:e044814. https://doi.org/10.1136/bmjopen-2020-044814
77. Wang XP, Lv D, Chen YF, Chen N, Li XD, Xu CF, Li Y, Tian L (2022) Impact of pain, agitation, and delirium bundle on delirium and cognitive function. J Nurs Res 30:e222. https://doi.org/10.1097/jnr.0000000000000497
78. Lewis K, Balas MC, Stollings JL, McNett M, Girard TD, Chanques G, Kho ME, Pandharipande PP, Weinhouse GL, Brummel NE, Chlan LL, Cordoza M, Duby JJ, Gelinas C, Hall-Melnychuk EL, Krupp A, Louzon PR, Tate JA, Young B, Jennings R, Hines A, Ross C, Carayannopoulos KL, Aldrich JM (2025) A focused update to the clinical practice guidelines for the

prevention and management of pain, anxiety, agitation/sedation, delirium, immobility, and sleep disruption in adult patients in the ICU. Crit Care Med 53:e711–e727. https://doi.org/10.1097/CCM.0000000000006574
79. Mikkelsen ME, Devlin JW (2021) The A2F bundle: quantity and quality matter. Crit Care Med 49:380–382. https://doi.org/10.1097/CCM.0000000000004794
80. Kotfis K, van Diem-Zaal I, Williams Roberson S, Sietnicki M, van den Boogaard M, Shehabi Y, Ely EW (2022) The future of intensive care: delirium should no longer be an issue. Crit Care 26:200. https://doi.org/10.1186/s13054-022-04077-y
81. Schaller SJ, Scheffenbichler FT, Bein T, Blobner M, Grunow JJ, Hamsen U, Hermes C, Kaltwasser A, Lewald H, Nydahl P, Reisshauer A, Renzewitz L, Siemon K, Staudinger T, Ullrich R, Weber-Carstens S, Wrigge H, Zergiebel D, Coldewey SM (2024) Guideline on positioning and early mobilisation in the critically ill by an expert panel. Intensive Care Med 50:1211–1227. https://doi.org/10.1007/s00134-024-07532-2
82. Devlin JW, Skrobik Y, Gelinas C, Needham DM, Slooter AJC, Pandharipande PP, Watson PL, Weinhouse GL, Nunnally ME, Rochwerg B, Balas MC, van den Boogaard M, Bosma KJ, Brummel NE, Chanques G, Denehy L, Drouot X, Fraser GL, Harris JE, Joffe AM, Kho ME, Kress JP, Lanphere JA, McKinley S, Neufeld KJ, Pisani MA, Payen JF, Pun BT, Puntillo KA, Riker RR, Robinson BRH, Shehabi Y, Szumita PM, Winkelman C, Centofanti JE, Price C, Nikayin S, Misak CJ, Flood PD, Kiedrowski K, Alhazzani W (2018) Clinical practice guidelines for the prevention and management of pain, agitation/sedation, delirium, immobility, and sleep disruption in adult patients in the ICU. Crit Care Med 46:e825–e873. https://doi.org/10.1097/CCM.0000000000003299
83. Daum N, Drewniok N, Bald A, Ulm B, Buyukli A, Grunow JJ, Schaller SJ (2024) Early mobilisation within 72 hours after admission of critically ill patients in the intensive care unit: a systematic review with network meta-analysis. Intensive Crit Care Nurs 80:103573. https://doi.org/10.1016/j.iccn.2023.103573
84. Investigators TS, the ACTG, Hodgson CL, Bailey M, Bellomo R, Brickell K, Broadley T, Buhr H, Gabbe BJ, Gould DW, Harrold M, Higgins AM, Hurford S, Iwashyna TJ, Serpa Neto A, Nichol AD, Presneill JJ, Schaller SJ, Sivasuthan J, Tipping CJ, Webb S, Young PJ (2022) Early active mobilization during mechanical ventilation in the ICU. N Engl J Med. https://doi.org/10.1056/NEJMoa2209083
85. Carayannopoulos KL, Chaudhuri D, McNett M, Balas MC, Kho ME, Stollings J, Young B, Krupp A, Kim AJ, Chowdhury SR, Chen JZX, Harris P, Kim S, Manalo J, Kocaqi E, Dearness K, Aldrich JM, Lewis K (2025) Effect of enhanced versus usual mobilization activities in critically ill adults: a systematic review and meta-analysis of randomized controlled trials. Crit Care Med 53:e2282–e2293. https://doi.org/10.1097/CCM.0000000000006840
86. Paton M, Chan S, Serpa Neto A, Tipping CJ, Stratton A, Lane R, Romero L, Broadley T, Hodgson CL (2024) Association of active mobilisation variables with adverse events and mortality in patients requiring mechanical ventilation in the intensive care unit: a systematic review and meta-analysis. Lancet Respir Med 12:386–398. https://doi.org/10.1016/S2213-2600(24)00011-0
87. Nydahl P, Sricharoenchai T, Chandra S, Kundt FS, Huang M, Fischill M, Needham DM (2017) Safety of patient mobilization and rehabilitation in the intensive care unit. Systematic review with meta-analysis. Ann Am Thorac Soc 14:766–777. https://doi.org/10.1513/AnnalsATS.201611-843SR
88. Hodgson CL, Stiller K, Needham DM, Tipping CJ, Harrold M, Baldwin CE, Bradley S, Berney S, Caruana LR, Elliott D, Green M, Haines K, Higgins AM, Kaukonen KM, Leditschke IA, Nickels MR, Paratz J, Patman S, Skinner EH, Young PJ, Zanni JM, Denehy L, Webb SA (2014) Expert consensus and recommendations on safety criteria for active mobilization of mechanically ventilated critically ill adults. Crit Care 18:658. https://doi.org/10.1186/s13054-014-0658-y
89. Stelfox HT, Leigh JP, Dodek PM, Turgeon AF, Forster AJ, Lamontagne F, Fowler RA, Soo A, Bagshaw SM (2017) A multi-center prospective cohort study of patient transfers from the intensive care unit to the hospital ward. Intensive Care Med 43:1485–1494. https://doi.org/10.1007/s00134-017-4910-1
90. Gustafson OD, Vollam S, Morgan L, Watkinson P (2021) A human factors analysis of missed mobilisation after discharge from intensive care: a competition for care? Physiotherapy 113:131–137. https://doi.org/10.1016/j.physio.2021.03.013
91. NICE (2009) Clinical guideline: rehabilitation after critical illness in adults. https://www.nice.org.uk/guidance/cg83
92. Cazeta BBR, de Queiroz RS, Nacimento TS, Ferreira BR, Saquetto MB, Martinez BP, Carvalho VO, Gomes-Neto M (2024) Effects of exercise interventions on functioning and health-related quality of life following hospital discharge for recovery from critical illness: a systematic review and meta-analysis of randomized trials. Clin Rehabil 38:898–909. https://doi.org/10.1177/02692155241241665
93. Shimizu M, Yoshihiro S, Watanabe S, Aikawa G, Fujinami Y, Kawamura Y, Matsuoka A, Nakanishi N, Shida H, Sugimoto K, Taito S, Inoue S (2024) Efficacy of enhanced rehabilitation initiated after hospital discharge to improve quality of life in survivors of critical care: a systematic review and meta-analysis of randomized controlled trials. Cureus 16:e75184. https://doi.org/10.7759/cureus.75184
94. O'Neill B, Bradley JM, Connolly B, Bruce J, Ratna M, Lall R, Underwood M, Ji C, Costley J, Clarke R, Dark P, Duffy O, Firshman P, Hart ND, Henderson A, Jones K, Kenyon R, Madan J, Murphy D, Perkins GD, Raynes K, Terblanche E, Zanganeh M, McAuley DF, iRehab Trial I (2026) Remote multicomponent rehabilitation in intensive care unit survivors: a randomized clinical trial. JAMA. https://doi.org/10.1001/jama.2026.7401
95. Chatterjee S, Tripathy S, Nayak S, Chakravarty R, Rao PB (2025) Post-intensive care unit clinics: models and implementation—a systematic review. Crit Care 29:421. https://doi.org/10.1186/s13054-025-05634-x
96. Dimopoulos S, Leggett NE, Deane AM, Haines KJ, Abdelhamid YA (2024) Models of intensive care unit follow-up care and feasibility of intervention delivery: a systematic review. Aust Crit Care 37:508–516. https://doi.org/10.1016/j.aucc.2023.04.005
97. Sharshar T, Grimaldi-Bensouda L, Siami S, Cariou A, Salah AB, Kalfon P, Sonneville R, Meunier-Beillard N, Quenot JP, Megarbane B, Gaudry S, Oueslati H, Robin-Lagandre S, Schwebel C, Mazeraud A, Annane D, Nkam L, Friedman D, Suivi-Rea I (2024) A randomized clinical trial to evaluate the effect of post-intensive care multidisciplinary consultations on mortality and the quality of life at 1 year. Intensive Care Med 50:665–677. https://doi.org/10.1007/s00134-024-07359-x
98. Kanschik D, Bruno RR, Wolff G, Kelm M, Jung C (2023) Virtual and augmented reality in intensive care medicine: a systematic review. Ann Intensive Care 13:81. https://doi.org/10.1186/s13613-023-01176-z
99. McPeake J, Hirshberg EL, Christie LM, Drumright K, Haines K, Hough CL, Meyer J, Wade D, Andrews A, Bakhru R, Bates S, Barwise JA, Bastarache J, Beesley SJ, Boehm LM, Brown S, Clay AS, Firshman P, Greenberg S, Harris W, Hill C, Hodgson C, Holdsworth C, Hope AA, Hopkins RO, Howell DCJ, Janssen A, Jackson JC, Johnson A, Kross EK, Lamas D, MacLeod-Smith B, Mandel R, Marshall J, Mikkelsen ME, Nackino M, Quasim T, Sevin CM, Slack A, Spurr R, Still M, Thompson C, Weinhouse G, Wilcox ME, Iwashyna TJ (2019) Models of peer support to remediate post-intensive care syndrome: a report developed by the society of critical care medicine thrive international peer support collaborative. Crit Care Med 47:e21–e27. https://doi.org/10.1097/CCM.0000000000003497
100. Leggett N, Ali Abdelhamid Y, Bicknell E, Booth S, Carmody J, Deane AM, Farley KJ, Karahalios A, Merolli M, Haines KJ, icu Ri (2024) Virtual peer support for ICU survivors is feasible and may improve outcomes for ICU survivors: results from the icuRESOLVE-D (icu Recovery Solutions Codesigned through Survivor Engagement-Digital) pilot randomized controlled trial. Am J Respir Crit Care Med 210:1273–1276. https://doi.org/10.1164/rccm.202404-0780RL
101. Zuo J, Li J, Cai L, Zhen H, Xu Y, Sun T, Ye X (2025) The effect of ICU diaries on psychological outcomes and quality of life of patients and relatives: overview of systematic reviews. J Clin Nurs 34:4899–4914. https://doi.org/10.1111/jocn.17832
102. Garrouste-Orgeas M, Flahault C, Vinatier I, Rigaud JP, Thieulot-Rolin N, Mercier E, Rouget A, Grand H, Lesieur O, Tamion F, Hamidfar R, Renault A, Parmentier-Decrucq E, Monseau Y, Argaud L, Bretonniere C, Lautrette A, Badie J, Boulet E, Floccard B, Forceville X, Kipnis E, Soufir L, Valade S, Bige N, Gaffinel A, Hamzaoui O, Simon G, Thirion M, Bouadma L, Large A, Mira JP, Amdjar-Badidi N, Jourdain M, Jost PH, Maxime V, Santoli F, Ruckly S, Vioulac C, Leborgne MA, Bellalou L, Fasse L, Misset B, Bailly S, Timsit JF (2019) Effect of an ICU diary on posttraumatic stress disorder symptoms among patients receiving mechanical ventilation:

a randomized clinical trial. JAMA 322:229–239. https://doi.org/10.1001/jama.2019.9058
103. Hwang DY, Oczkowski SJW, Lewis K, Birriel B, Downar J, Farrier CE, Fiest KM, Gerritsen RT, Hart J, Hartog CS, Heras-La Calle G, Hope AA, Jennerich AL, Kentish-Barnes N, Kleinpell R, Kross EK, Marshall AP, Nydahl P, Peters T, Rosa RG, Scruth E, Sederstrom N, Stollings JL, Turnbull AE, Valley TS, Netzer G, Aslakson RA, Hopkins RO (2025) Society of critical care medicine guidelines on family-centered care for adult ICUs: 2024. Crit Care Med 53:e465–e482. https://doi.org/10.1097/CCM.0000000000006549
104. Duong J, Wang G, Lean G, Slobod D, Goldfarb M (2024) Family-centered interventions and patient outcomes in the adult intensive care unit: a systematic review of randomized controlled trials. J Crit Care 83:154829. https://doi.org/10.1016/j.jcrc.2024.154829
105. Naef R (2026) Nurse-led, multicomponent models of family care in adult intensive care units. Intensive Crit Care Nurs 93:104293. https://doi.org/10.1016/j.iccn.2025.104293
106. van Sleeuwen D, Zegers M, Ramjith J, Cruijsberg JK, Simons KS, van Bommel D, Burgers-Bonthuis D, Koeter J, Bisschops LLA, Janssen I, Rettig TCD, van der Hoeven JG, van de Laar FA, van den Boogaard M (2024) Prediction of long-term physical, mental, and cognitive problems following critical illness: development and external validation of the PROSPECT prediction model. Crit Care Med 52:200–209. https://doi.org/10.1097/CCM.0000000000006073
107. Sadjadi M, Marcello M, Drammeh M, Booke H, Hognon-Bak K, Aistleitner L, Schone LM, Strauss C, Mertes MJ, Zarbock A (2026) Association between organ dysfunction during ICU stay and post-intensive care syndrome at 1 year after ICU discharge: a prospective cohort study. J Intensive Care. https://doi.org/10.1186/s40560-026-00885-4
108. Tipping CJ, Harrold M, Holland A, Romero L, Nisbet T, Hodgson CL (2017) The effects of active mobilisation and rehabilitation in ICU on mortality and function: a systematic review. Intensive Care Med 43:171–183. https://doi.org/10.1007/s00134-016-4612-0
109. Jiroutkova K, Duska F, Waldauf P (2024) Should new data on rehabilitation interventions in critically ill patients change clinical practice? Updated meta-analysis of randomized controlled trials. Crit Care Med. https://doi.org/10.1097/CCM.0000000000006259
110. Patel BK, Wolfe KS, Patel SB, Dugan KC, Esbrook CL, Pawlik AJ, Stulberg M, Kemple C, Teele M, Zeleny E, Hedeker D, Pohlman AS, Arora VM, Hall JB, Kress JP (2023) Effect of early mobilisation on long-term cognitive impairment in critical illness in the USA: a randomised controlled trial. Lancet Respir Med. https://doi.org/10.1016/S2213-2600(22)00489-1
111. Eggmann S, Parry SM, Broadley T, Lynch GS, Bongetti AJ, Ridley EJ, Ayre E, Bailey M, Bellomo R, Berney S, Bradley S, Buhr H, Campbell MK, Casey K, Chapple LS, Connolly B, Darvall J, Deane A, Febbraio MA, Gosselink R, Granger CL, Haines K, Hanekom S, Harhay MO, Harrold M, Hayes K, Hermans G, Higgins A, Jain S, Kho ME, Kumar Tirupakuzhi Vijayaraghavan B, Lambell K, Lang JK, Leditschke IA, Levinger I, Magana Cruz S, Marshall AP, Needham DM, Ntoumenopoulos G, Nydahl P, Patel BK, Paton M, Puthucheary Z, Rooyackers O, Schaller SJ, Serpa Neto A, Stoppe C, Tronstad O, Vanhorebeek I, Z'Graggen WJ, Hodgson CL (2025) The intensive care medicine research agenda for the management of ICU acquired weakness: a multinational, interprofessional perspective. Intensive Care Med 51:2199–2212. https://doi.org/10.1007/s00134-025-08186-4
112. Grunow JJ, Goll M, Carbon NM, Liebl ME, Weber-Carstens S, Wollersheim T (2019) Differential contractile response of critically ill patients to neuromuscular electrical stimulation. Crit Care 23:308. https://doi.org/10.1186/s13054-019-2540-4
113. Lindholz M, Schellenberg CM, Grunow JJ, Kagerbauer S, Milnik A, Zickler D, Angermair S, Reisshauer A, Witzenrath M, Menk M, Boie S, Balzer F, Schaller SJ (2022) Mobilisation of critically ill patients receiving norepinephrine: a retrospective cohort study. Crit Care 26:362. https://doi.org/10.1186/s13054-022-04245-0
114. Wang YT, Haines TP, Ritchie P, Walker C, Ansell TA, Ryan DT, Lim PS, Vij S, Acs R, Fealy N, Skinner EH (2014) Early mobilization on continuous renal replacement therapy is safe and may improve filter life. Crit Care 18:R161. https://doi.org/10.1186/cc14001
115. Fuest KE, Ulm B, Daum N, Lindholz M, Lorenz M, Blobner K, Langer N, Hodgson C, Herridge M, Blobner M, Schaller SJ (2023) Clustering of critically ill patients using an individualized learning approach enables dose optimization of mobilization in the ICU. Crit Care 27:1. https://doi.org/10.1186/s13054-022-04291-8
116. Serpa Neto A, Bailey M, Seller D, Agli A, Bellomo R, Brickell K, Broadley T, Buhr H, Gabbe BJ, Gould DW, Harrold M, Higgins AM, Hurford S, Iwashyna TJ, Nichol AD, Presneill JJ, Schaller SJ, Sivasuthan J, Tipping CJ, Poole A, Parke R, Bradley S, Webb S, Zoungas S, Young PJ, Hodgson CL, Investigators TS (2024) Impact of high-dose early mobilization on outcomes for patients with diabetes: a secondary analysis of the TEAM trial. Am J Respir Crit Care Med 210:779–787. https://doi.org/10.1164/rccm.202312-2289OC
117. Hodgson CL, Spicer AB, Broadley T, Bailey M, Bellomo R, Brickell K, Buhr H, Gabbe BJ, Gould DW, Harrold M, Higgins AM, Hurford S, Iwashyna TJ, Serpa Neto A, Nichol AD, Presneill JJ, Schaller SJ, Sivasuthan J, Tipping CJ, Webb S, Graham Linck EJ, Sinha P, Semler MW, Young PJ, Churpek MM (2026) Individualised treatment effects of enhanced early mobilisation in mechanically ventilated patients: a secondary analysis of the TEAM trial. Intensive Care Med 52:11–21. https://doi.org/10.1007/s00134-025-08217-0
118. Hermes C, Nydahl P, Blobner M, Dubb R, Filipovic S, Kaltwasser A, Ulm B, Schaller SJ (2020) Assessment of mobilization capacity in 10 different ICU scenarios by different professions. PLoS ONE 15:e0239853. https://doi.org/10.1371/journal.pone.0239853
119. Connolly B, Milton-Cole R, Adams C, Battle C, McPeake J, Quasim T, Silversides J, Slack A, Waldmann C, Wilson E, Meyer J, Faculty of Intensive Care Medicine Life After Critical Illness Working G (2021) Recovery, rehabilitation and follow-up services following critical illness: an updated UK national cross-sectional survey and progress report. BMJ Open 11:e052214. https://doi.org/10.1136/bmjopen-2021-052214
120. (2025) The national confidential enquiry into patient outcome and death. Recovery Beyond Survival. 2025. London
121. Hopkins RO, Miller RR 3rd, Rodriguez L, Spuhler V, Thomsen GE (2012) Physical therapy on the wards after early physical activity and mobility in the intensive care unit. Phys Ther 92:1518–1523. https://doi.org/10.2522/ptj.20110446
122. Connolly B, Salisbury L, O'Neill B, Geneen L, Douiri A, Grocott MP, Hart N, Walsh TS, Blackwood B, Group E (2015) Exercise rehabilitation following intensive care unit discharge for recovery from critical illness. Cochrane Database Syst Rev 2015:CD008632. https://doi.org/10.1002/14651858.CD008632.pub2
123. McWilliams D, Gustafson O, Wyer N, Couper K, Kimani PK, Kandiyali R, El-Banna A, Barghouthy D, Haylett R, King E, Richardson H, Negus-Fancey M, Gallie L, Matthews V, Puthucheary Z (2026) Physiotherapy and optimised enteral nutrition in the post-acute phase of critical illness (PHOENIX): a randomised controlled feasibility trial. EClinicalMedicine 96:104000. https://doi.org/10.1016/j.eclinm.2026.104000
124. Moisey LL, Merriweather JL, Drover JW (2022) The role of nutrition rehabilitation in the recovery of survivors of critical illness: underrecognized and underappreciated. Crit Care 26:270. https://doi.org/10.1186/s13054-022-04143-5
125. Walsh TS, Salisbury LG, Merriweather JL, Boyd JA, Griffith DM, Huby G, Kean S, Mackenzie SJ, Krishan A, Lewis SC, Murray GD, Forbes JF, Smith J, Rattray JE, Hull AM, Ramsay P, Investigators R (2015) Increased hospital-based physical rehabilitation and information provision after intensive care unit discharge: the RECOVER randomized clinical trial. JAMA Intern Med 175:901–910. https://doi.org/10.1001/jamainternmed.2015.0822
126. Bourne RS, Jennings JK, Panagioti M, Hodkinson A, Sutton A, Ashcroft DM (2022) Medication-related interventions to improve medication safety and patient outcomes on transition from adult intensive care settings: a systematic review and meta-analysis. BMJ Qual Saf 31:609–622. https://doi.org/10.1136/bmjqs-2021-013760
127. Puthucheary Z, Brown C, Corner E, Wallace S, Highfield J, Bear D, Rehill N, Montgomery H, Aitken L, Turner-Stokes L (2022) The Post-ICU presentation screen (PICUPS) and rehabilitation prescription (RP) for intensive care survivors part II: Clinical engagement and future directions for the national Post-Intensive care Rehabilitation Collaborative. J Intensive Care Soc 23:264–272. https://doi.org/10.1177/1751143720988708
128. Inoue S, Nakanishi N, Amaya F, Fujinami Y, Hatakeyama J, Hifumi T, Iida Y, Kawakami D, Kawai Y, Kondo Y, Liu K, Nakamura K, Nishida T, Sumita H, Taito S, Takaki S, Tsuboi N, Unoki T, Yoshino Y, Nishida O (2024) Post-intensive care syndrome: recent advances and future directions. Acute Med Surg 11:e929. https://doi.org/10.1002/ams2.929

129. Nakanishi N, Liu K, Hatakeyama J, Kawauchi A, Yoshida M, Sumita H, Miyamoto K, Nakamura K (2024) Post-intensive care syndrome follow-up system after hospital discharge: a narrative review. J Intensive Care 12:2. https://doi.org/10.1186/s40560-023-00716-w
130. O'Neill B, Bradley JM, Connolly B, Bruce J, Ratna M, Lall R, Underwood M, Ji C, Costley J, Clarke R, Dark P, Duffy O, Firshman P, Hart ND, Henderson A, Jones K, Kenyon R, Madan J, Murphy D, Perkins GD, Raynes K, Terblanche E, Zanganeh M, McAuley DF, iRehab Trial I (2026) Remote multicomponent rehabilitation in intensive care unit survivors: a randomized clinical trial. JAMA 336:236–247. https://doi.org/10.1001/jama.2026.7401
131. Rosa RG, Walsh TS (2024) Navigating complex interventions in post-ICU care: insights from a randomized clinical trial of post-intensive care multidisciplinary consultations. Intensive Care Med 50:725–727. https://doi.org/10.1007/s00134-024-07414-7
132. Skivington K, Matthews L, Simpson SA, Craig P, Baird J, Blazeby JM, Boyd KA, Craig N, French DP, McIntosh E, Petticrew M, Rycroft-Malone J, White M, Moore L (2021) A new framework for developing and evaluating complex interventions: update of Medical Research Council guidance. BMJ 374:n2061. https://doi.org/10.1136/bmj.n2061
133. Agbakou M, Combet M, Martin M, Blonz G, Desmedt L, Seguin A, Lemarie J, Zambon O, Reignier J, Lascarrou JB, Ehrmann S, Canet E (2024) Post-intensive care syndrome screening: a French multicentre survey. Ann Intensive Care 14:109. https://doi.org/10.1186/s13613-024-01341-y
134. Murthy S, Wunsch H (2012) Clinical review: international comparisons in critical care - lessons learned. Crit Care 16:218. https://doi.org/10.1186/cc11140
135. Merdji H, Long MT, Ostermann M, Herridge M, Myatra SN, De Rosa S, Metaxa V, Kotfis K, Robba C, De Jong A, Helms J, Gebhard CE (2023) Sex and gender differences in intensive care medicine. Intensive Care Med 49:1155–1167. https://doi.org/10.1007/s00134-023-07194-6
136. Lat TI, McGraw MK, White HD (2021) Gender differences in critical illness and critical care research. Clin Chest Med 42:543–555. https://doi.org/10.1016/j.ccm.2021.04.012
137. Schandl A, Bottai M, Hellgren E, Sundin O, Sackey P (2012) Gender differences in psychological morbidity and treatment in intensive care survivors—a cohort study. Crit Care 16:R80. https://doi.org/10.1186/cc11338
138. Min SY, Yong HJ, Kim D (2024) Sex or gender differences in treatment outcomes of sepsis and septic shock. Acute Crit Care 39:207–213. https://doi.org/10.4266/acc.2024.00591
139. Johnson GU, Esmeralda BY, Pearson S, Ewens B, Rose L (2026) Personal family-centred care for LGBTQ+ individuals in acute hospital settings: a scoping review. J Clin Nurs 35:2909–2920. https://doi.org/10.1111/jocn.70268
140. Ito Y, Tsubaki M, Kobayashi M, Yagome S, Sakaguchi Y (2023) Effect size estimates of risk factors for post-intensive care syndrome-family: a systematic review and meta-analysis. Heart Lung 59:1–7. https://doi.org/10.1016/j.hrtlng.2023.01.005
141. Smith AC, Ferguson HN, Russell RM, Savsani P, Wang S (2025) Post-intensive care syndrome family. Crit Care Clin 41:73–88. https://doi.org/10.1016/j.ccc.2024.08.008
142. Gravante F, Trotta F, Latina S, Simeone S, Alvaro R, Vellone E, Pucciarelli G (2024) Quality of life in ICU survivors and their relatives with post-intensive care syndrome: a systematic review. Nurs Crit Care. https://doi.org/10.1111/nicc.13077
143. Brown C, Hartley P, Forsyth F, Boehm LM, Martin G, Kuhn I, Pattison N, Connolly B, Lone N, Danesh V, McPeake J (2025) What measures have been used to explore the outcomes of family members of critically ill patients: a scoping review. Intensive Care Med. https://doi.org/10.1007/s00134-025-08072-z
144. Hayes K, Harding S, Blackwood B, Latour JM (2024) How and when post intensive care syndrome-family is measured: a scoping review. Intensive Crit Care Nurs 84:103768. https://doi.org/10.1016/j.iccn.2024.103768
145. Nakanishi N, Liu K, Kawauchi A, Okamura M, Tanaka K, Katayama S, Mitani Y, Ota K, Taito S, Fudeyasu K, Masuka Y, Yoshihiro S, Utsumi S, Nishikimi M, Masuda M, Iida Y, Kawai Y, Hatakeyama J, Hifumi T, Unoki T, Kawakami D, Obata K, Katsukawa H, Sumita H, Morisawa T, Takahashi M, Tsuboi N, Kozu R, Takaki S, Haruna J, Fujinami Y, Nosaka N, Miyamoto K, Nakamura K, Kondo Y, Inoue S, Nishida O (2023) Instruments to assess post-intensive care syndrome assessment: a scoping review and modified Delphi method study. Crit Care 27:430. https://doi.org/10.1186/s13054-023-04681-6
146. Wang G, Antel R, Goldfarb M (2023) The impact of randomized family-centered interventions on family-centered outcomes in the adult intensive care unit: a systematic review. J Intensive Care Med 38:690–701. https://doi.org/10.1177/08850666231173868
147. Naef R (2026) Nurse-led, multicomponent models of ICU family care in adult intensive care units. Intensive Crit Care Nurs 93:104293. https://doi.org/10.1016/j.iccn.2025.104293
148. Kesecioglu J, Rusinova K, Alampi D, Arabi YM, Benbenishty J, Benoit D, Boulanger C, Cecconi M, Cox C, van Dam M, van Dijk D, Downar J, Efstathiou N, Endacott R, Galazzi A, van Gelder F, Gerritsen RT, Girbes A, Hawyrluck L, Herridge M, Hudec J, Kentish-Barnes N, Kerckhoffs M, Latour JM, Malaska J, Marra A, Meddick-Dyson S, Mentzelopoulos S, Mer M, Metaxa V, Michalsen A, Mishra R, Mistraletti G, van Mol M, Moreno R, Nelson J, Suner AO, Pattison N, Prokopova T, Puntillo K, Puxty K, Qahtani SA, Radbruch L, Rodriguez-Ruiz E, Sabar R, Schaller SJ, Siddiqui S, Sprung CL, Umbrello M, Vergano M, Zambon M, Zegers M, Darmon M, Azoulay E (2024) European Society of Intensive Care Medicine guidelines on end of life and palliative care in the intensive care unit. Intensive Care Med 50:1740–1766. https://doi.org/10.1007/s00134-024-07579-1
149. Bannon SM, Cornelius T, Gates MV, Lester E, Mace RA, Popok P, Macklin EA, Rosand J, Vranceanu AM (2022) Emotional distress in neuro-ICU survivor-caregiver dyads: the recovering together randomized clinical trial. Health Psychol 41:268–277. https://doi.org/10.1037/hea0001102
150. Zhang Z, Yang L, Cao H (2024) The interactivity and independence of Recovery challenges and coping strategies for ICU survivors and their caregivers: a systematic review and meta-synthesis. BMC Nurs 23:895. https://doi.org/10.1186/s12912-024-02542-3
151. Manning JC, Pinto NP, Rennick JE, Colville G, Curley MAQ (2018) Conceptualizing post intensive care syndrome in children-the PICS-p framework. Pediatr Crit Care Med 19:298–300. https://doi.org/10.1097/PCC.0000000000001476
152. Manning JC, Latour JM, Draper E, Quinlan P, Popejoy EM, Figueredo G, Iyer S, Trimble T, Menzies J, Curley MAQ, Coad J, Investigators OS (2026) One year quality of life outcomes in critically ill children: a multi-center prospective cohort study. Crit Care. https://doi.org/10.1186/s13054-026-06084-9
153. Davidson JE, Aslakson RA, Long AC, Puntillo KA, Kross EK, Hart J, Cox CE, Wunsch H, Wickline MA, Nunnally ME, Netzer G, Kentish-Barnes N, Sprung CL, Hartog CS, Coombs M, Gerritsen RT, Hopkins RO, Franck LS, Skrobik Y, Kon AA, Scruth EA, Harvey MA, Lewis-Newby M, White DB, Swoboda SM, Cooke CR, Levy MM, Azoulay E, Curtis JR (2017) Guidelines for family-centered care in the neonatal, pediatric, and adult ICU. Crit Care Med 45:103–128. https://doi.org/10.1097/CCM.0000000000002169
154. Naef R, Jeitziner MM, Riguzzi M, von Felten S, Verweij L, Rufer M, Safford J, Sutter S, Bergmann-Kipfer B, Betschart U, Boltshauser S, Brulisauer N, Brunner C, Buhler PK, Burkhalter H, Dullenkopf A, Heise A, Hertler B, Hoffmann JE, Karde C, Keller Y, Kohler S, Lussmann F, Massarotto P, Moser M, Pietsch U, Segalada DL, Siegrist E, Steiger P, Ruch N, von Dach C, Wenzler MS, Wiegand J, Zante B, Filipovic M, Group FS (2025) Nurse-led family support intervention for families of critically ill patients: the FICUS cluster randomized clinical trial. JAMA Intern Med 185:1138–1149. https://doi.org/10.1001/jamainternmed.2025.3406
155. Parker A, Sricharoenchai T, Needham DM (2013) Early rehabilitation in the intensive care unit: preventing physical and mental health impairments. Curr Phys Med Rehabil Rep 1:307–314. https://doi.org/10.1007/s40141-013-0027-9
156. Marra A, Ely EW, Pandharipande PP, Patel MB (2017) The ABCDEF bundle in critical care. Crit Care Clin 33:225–243. https://doi.org/10.1016/j.ccc.2016.12.005
157. Major ME, Kwakman R, Kho ME, Connolly B, McWilliams D, Denehy L, Hanekom S, Patman S, Gosselink R, Jones C, Nollet F, Needham DM, Engelbert RH, van der Schaaf M (2016) Surviving critical illness: what is next? An expert consensus statement on physical rehabilitation after hospital discharge. Crit Care 20:354. https://doi.org/10.1186/s13054-016-1508-x

158. Schaller SJ, Anstey M, Blobner M, Edrich T, Grabitz SD, Gradwohl-Matis I, Heim M, Houle T, Kurth T, Latronico N, Lee J, Meyer MJ, Peponis T, Talmor D, Velmahos GC, Waak K, Walz JM, Zafonte R, Eikermann M, International Early S-gMRI (2016) Early, goal-directed mobilisation in the surgical intensive care unit: a randomised controlled trial. Lancet 388:1377–1388. https://doi.org/10.1016/S0140-6736(16)31637-3
159. Hampton SF, Carlbom D, Steinkruger S, Heshelman KA, Askevold J, Hogle JM, Osaki MT, Shelton MM, Berger G (2022) Interprofessional education module on post-intensive care syndrome for internal medicine residents. ATS Sch 3:324–331. https://doi.org/10.34197/ats-scholar.2021-0114IN
160. Balas MC, Pun BT, Pasero C, Engel HJ, Perme C, Esbrook CL, Kelly T, Hargett KD, Posa PJ, Barr J, Devlin JW, Morse A, Barnes-Daly MA, Puntillo KA, Aldrich JM, Schweickert WD, Harmon L, Byrum DG, Carson SS, Ely EW, Stollings JL (2019) Common challenges to effective ABCDEF bundle implementation: the ICU liberation campaign experience. Crit Care Nurse 39:46–60. https://doi.org/10.4037/ccn2019927
161. McNett M, O'Mathuna D, Tucker S, Roberts H, Mion LC, Balas MC (2020) A scoping review of implementation science in adult critical care settings. Crit Care Explor 2:e0301. https://doi.org/10.1097/CCE.0000000000000301
162. Su H, Fuentes AL, Chen H, Malhotra A, Gallo LC, Song Y, Moore RC, Kamdar BB (2025) The financial impact of post intensive care syndrome. Crit Care Clin 41:103–119. https://doi.org/10.1016/j.ccc.2024.08.003
163. Teisberg E, Wallace S, O'Hara S (2020) Defining and implementing value-based health care: a strategic framework. Acad Med 95:682–685. https://doi.org/10.1097/ACM.0000000000003122
164. Zacharelou A, Munjas Samarin R, Mikulcic K, Brcina A, Friganovic A, Jones C, Nydahl P, Van Mol MMC (2025) Value-based experiences related to digital follow-up services among critical care survivors: an international qualitative study. Nurs Health Sci 27:e70135. https://doi.org/10.1111/nhs.70135
165. Obermeyer Z, Powers B, Vogeli C, Mullainathan S (2019) Dissecting racial bias in an algorithm used to manage the health of populations. Science 366:447–453. https://doi.org/10.1126/science.aax2342
166. Rajkomar A, Hardt M, Howell MD, Corrado G, Chin MH (2018) Ensuring fairness in machine learning to advance health equity. Ann Intern Med 169:866–872. https://doi.org/10.7326/M18-1990
167. Ghassemi M, Oakden-Rayner L, Beam AL (2021) The false hope of current approaches to explainable artificial intelligence in health care. Lancet Dig Health 3:e745–e750. https://doi.org/10.1016/S2589-7500(21)00208-9
168. Koenig HG (2012) Religion, spirituality, and health: the research and clinical implications. ISRN Psychiatry 2012:278730. https://doi.org/10.5402/2012/278730
169. Badanta B, Rivilla-Garcia E, Lucchetti G, de Diego-Cordero R (2022) The influence of spirituality and religion on critical care nursing: an integrative review. Nurs Crit Care 27:348–366. https://doi.org/10.1111/nicc.12645
170. Beauchamp TL, Childress JF (2019) Principles of biomedical ethics. Oxford University Press, New York
171. Balboni TA, Balboni M, Enzinger AC, Gallivan K, Paulk ME, Wright A, Steinhauser K, VanderWeele TJ, Prigerson HG (2013) Provision of spiritual support to patients with advanced cancer by religious communities and associations with medical care at the end of life. JAMA Intern Med 173:1109–1117. https://doi.org/10.1001/jamainternmed.2013.903
172. Handzo G, Koenig HG (2004) Spiritual care: whose job is it anyway? South Med J 97:1242–1244. https://doi.org/10.1097/01.SMJ.0000146490.49723.AE