# Chapter 2
# Implementing Early Mobilisation in the Intensive Care Unit


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## What Is the Impact of Implementing Early Mobilisation in the Intensive Care Unit?

As critical care survivorship improves, research has increasingly focused on interventions which may prevent or manage critical illness-related morbidity [1]. Physically, intensive care impacts negatively on muscle and nerve structure and function with the literature supporting an incidence of intensive care unit-acquired weakness (ICU-AW) more than 50% in patients requiring prolonged mechanical ventilation [2, 3]. There is an association between ICU-AW and poorer outcomes including mortality, length of stay and physical function [3–5]. Early mobilisation

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(EM) has gained significant interest due to its potential to attenuate the negative effects of bed rest and thus improve service-centred and patient-centred outcomes. Whilst many studies report findings related to implementation of EM interventions, there remains no consistent definition of the term [6, 7]. Mobilisation "facilitates the movement of patients and expends energy with a goal of improving patient outcomes" [8]. Mobilisation can encompass a variety of interventions and forms one component of early rehabilitation which may also include treatments to address areas such as cognition, speech, swallowing and inspiratory muscle strength [8, 9]. In the intensive care unit (ICU), where traditionally patients have been managed with sedation and bed rest, the implementation of any mobilisation intervention during the critical illness period may have been considered early. However, it may be important to distinguish mobilisation delivered at different time points during critical illness. Mobilisation delivered early, within 48–72 hours of admission, may have the potential to stimulate muscle regeneration and consequently prevent or reduce the severity of sequelae of critical illness such as intensive care-acquired weakness (ICU-AW) and delirium [10–12]. It may also contribute to reduced mechanical ventilation (MV) time, length of stay (LOS) and improved long-term outcomes for critical illness survivors [8, 12]. Conversely, the rapid onset of muscle degeneration in critically ill patients means that physical rehabilitation applied later in or after an ICU admission aims to reverse impairments to improve outcomes. Selection of EM modalities for each individual patient depends upon medical stability and whether the patient can or cannot actively participate in mobilisation [13, 14].

For patients unable to actively participate in EM, neuromuscular electrical stimulation (NMES), cycling and passive movements are forms of rehabilitation that may be utilised in the ICU [14]. Reviews of clinical trials demonstrate that NMES may improve impairments such as muscle strength; however, there is no clear evidence for the impact of NMES on long-term outcomes [15, 16]. Two recent RCTs have investigated the effects of cycling in addition to early rehabilitation and have not demonstrated any significant changes in functional capacity, independence at hospital discharge, global muscle strength, ventilator-free days or health-related quality of life at 6 months [17, 18]. The feasibility of cycling has been demonstrated via pilot RCT, and ongoing trials are being completed in this area (NCT03471247) [19, 20]. As evidence emerges, systematic review which separately evaluates the effects of cycling and passive movement interventions may be warranted. To date, there is no available meta-analysis of the incidence of adverse events related to NMES or cycling in critically ill patients. Table 2.1 provides a summary of recent publications which have detailed the effects of passive cycling and EMS in critically ill patients.

For patients who are able to participate in active therapy, EM focuses on active exercises and functional retraining activities such as active exercises in bed or in the chair (aiming to improve muscle strength and joint mobilisation), sitting, balance, transfers, standing and walking. Multiple systematic reviews have been undertaken examining the short- and long-term effects of active participation in EM (Table 2.2). Results indicate that active participation in early rehabilitation may result in reduction in incidence of ICU-AW, hospital and ICU LOS whilst improving functional status at discharge and long-term quality of life. Three systematic reviews suggest

**Table 2.1** Publications evaluating the effect of early mobilisation interventions for intensive care patients which do not require active participation

| Author, year | Patient characteristics | Intervention characteristics | Quality of evidence | Outcomes |
|---|---|---|---|---|
| Parry et al. 2013 [15] Systematic Review | Adult patients admitted to the intensive care unit | Electrical muscle stimulation applied to peripheral muscles as an exercise intervention | Eight randomised controlled trials and one case–control study<br>Two studies of poor quality, four studies of fair to good quality as assessed on the PEDro scale | Early EMS application did not attenuate bicep or quadriceps muscle wasting<br>EMS may have a greater impact on muscle preservation in long-stay patients or those with lower illness acuity<br>Improvement in muscle strength related to the application of EMS |
| Zayed et al. 2019 [16] Systematic Review and Meta-Analysis | Adult patients admitted to the intensive care unit | *Intervention:* neuromuscular electrical stimulation in addition to usual care<br>*Comparator:* usual care including early functional rehabilitation | Six randomised controlled trials<br>Moderate to high risk of bias | No difference for global muscle strength at ICU discharge, ICU mortality, duration of mechanical ventilation or ICU length of stay. |
| Fossat et al. 2018 [17] Randomised Controlled Trial | Adult patients who were previously independent and expected to require an ICU length of stay >48 hours | *Intervention:* cycle ergometry and electrical muscle stimulation in addition to usual care<br>*Usual care:* standardised early rehabilitation programme | Single centre trial of 314 patients. | No difference in median MRC score at ICU discharge.<br>No difference in any outcome measures at ICU discharge or at 6 months. |

(continued)

**Table 2.1** (continued)

| Author, year | Patient characteristics | Intervention characteristics | Quality of evidence | Outcomes |
|---|---|---|---|---|
| Eggman et al. 2018 [18] Randomised Controlled Trial | Adult patients who were previously independent, requiring mechanical ventilation and expected to require an ICU length of stay >72 hours | *Intervention:* early progressive combined endurance and resistance training utilising a cycle ergometer and weights or therapist resistance in combination with usual care<br>*Usual care:* individually tailored physiotherapy including early mobilisation. | Single centre trial of 115 patients | No difference in functional capacity at hospital discharge.<br>No difference in incidence of ICU-AW at ICU discharge, length of stay in ICU or hospital or 6-month health-related quality of life |
| Wollersheim et al. 2019 [29] | Adult patients who were previously independent with a sepsis and multiorgan failure (SOFA score ≥ 9) within 72 h after ICU admission | *Intervention:* protocolised early physical therapy (including PROM) + daily 20 Min NMES and/or whole-body vibration (WBV)<br>*Usual care:* protocolised early physical therapy (including PROM)<br>*Historic control:* physician initiated mobilisation only on weekdays without prespecified goals | Single centre trial of 50 patients | No difference in functional capacity at hospital discharge.<br>No difference in incidence of ICU-AW at first awakening, ICU discharge or 12 -month follow-up<br>Prevention of muscle atrophy (myocyte cross-sectional area) by intervention. |
| Grunow et al. 2019 [30] | Adult patients who were previously independent with a sepsis and multiorgan failure (SOFA score ≥ 9) within 72 h after ICU admission | Post hoc analysis of Wollersheim et al. on contractile response to neuromuscular stimulation | Single centre trial of 50 patients | Patients show a differential contractile response to NMES, which appears to be dependent on the severity of illness and also relevant for potential outcome benefits. |

**Table 2.2** Systematic reviews of early mobilisation interventions which require active participation

| Author, Year | Patient Characteristics | Intervention Characteristics | Quality of Evidence | Outcomes |
|---|---|---|---|---|
| Tipping et al. 2017 [21] | Adult patients admitted to ICU >24 hours | *Included:* any of active exercises, functional mobility retraining, tilt table therapy, hoisting to a chair delivered during the ICU stay *Excluded:* passive therapies only, cycle ergometry or FES as a sole therapy *Comparator:* usual care | Fourteen randomised controlled or controlled clinical trials included Five studies with low quality, four studies of moderate quality, five studies of high quality assessed using the Cochrane risk of bias tool Overall meta-analysis limited by variation in selection and timing of outcome measures | No impact on mortality or discharge destination Improved muscle strength at ICU discharge for patients receiving rehabilitation Improved SF-36 at 6 months in studies implementing high dose rehabilitation. Increased number of days alive and out of hospital to 6 months for intervention participants receiving early and low dose rehabilitation |
| Fuke et al. 2018 [31] | Adult patients admitted to ICU. *Excluded:* Patients with TBI and stroke | Early rehabilitation which started earlier than usual care or was administered within 7 days of admission *Comparator:* standard care or no early rehabilitation | Six randomised controlled trials Quality of evidence considered low to very low due to risk of bias | Significant reduction in the incidence of ICU-AW associated with early rehabilitation. Significant improvement in MRC and long-term role physical score associated with early rehabilitation No significant difference in delirium free days, anxiety or depression. |

(continued)

**Table 2.2** (continued)

| Author, Year | Patient Characteristics | Intervention Characteristics | Quality of Evidence | Outcomes |
|---|---|---|---|---|
| Doiron et al. 2018 [32] | Adult patients admitted to ICU and requiring mechanical ventilation<br>*Excluded:* neuromuscular disease, spinal cord injury, cardiopulmonary arrest, raised ICP, advanced dementia or expected six-month mortality | Any of cycle ergometry, active exercises, functional mobility retraining or ADL practice during the ICU stay designed to commence earlier than the control group<br>*Comparator:* delayed intervention, usual care or inspiratory muscle training only | Four randomised or quasi-randomised controlled trials | Low-quality evidence for improved independent function at hospital discharge for early rehabilitation. Insufficient evidence for the effect of intervention timing on physical function, performance, adverse events, muscle strength or health-related quality of life. Low-quality evidence to support that adverse events are low for early rehabilitation |
| Zang et al. 2019 [22] | Adult patients admitted to intensive care | Early mobilisation and rehabilitation | 15 randomised controlled trials 1 trial at low risk of bias, 4 trials at unclear risk of bias, 10 trials at high risk of bias | No effect on mortality Early mobilisation associated with a significant reduction in incidence of ICU-AW, ICU length of stay and hospital length of stay. Favourable effect for muscle strength and Barthel Index at hospital discharge |

that interventions delivered earlier during the ICU stay may be more beneficial than those delivered later during admission [21–23]. Ding et al. [23] identified via network meta-analysis that ideal initiation of EM is within 48–72 hours of mechanical ventilation [21–23]. Additionally, a systematic review of 10 RCTs examining physical rehabilitation interventions delivered after ICU discharge, either in hospital or after hospital discharge, to patients who received mechanical ventilation has demonstrated moderate evidence that these programmes do not make a difference to quality of life [24]. Meta-analysis examining safety of active EM interventions in the ICU has demonstrated that potential safety events are low and events associated with consequences are rare [25]. Based on the currently available evidence of the risks and benefits of a variety of EM interventions, clinicians should focus on delivery of mobilisation activities delivered as early as possible during the ICU admission, with active participation wherever possible.

## Why Is Early Mobilisation Challenging to Implement into Clinical Practice in the Intensive Care Unit?

EM is a complex intervention and has been consistently difficult to implement in ICU in both clinical trials and clinical practice. Whilst there are concerns for patient's safety and physiological stability, the main reported barriers to EM, such as sedation and staff levels, may be managed with multidisciplinary team input and coordination [26].

In a multicentre observational study of EM in critically ill patients, during 1288 planned early mobilisation episodes in patients on mechanical ventilation, no mobilisation occurred in 1079 (84%) of these episodes despite the presence of dedicated physical therapy staff. The main reported barrier to EM in the first 7 days after enrolment was intubation and sedation [2]. At day 7, the reported barriers also included agitation and weakness. However, EM has been shown to be safe and feasible in intubated patients and can occur in conjunction with sedation minimisation or disruption, so why does this continue to be a barrier to implementation in the clinical setting?

First, EM is easier to implement in an ICU that has a culture that prioritises and values rehabilitation and functional recovery [2]. In this case, maximising the opportunities to safely implement EM occurs with discussion on the multidisciplinary round, accompanied by clear goal setting based on the patient's current status and with a plan to implement EM as a coordinated effort by the ICU team [12]. The type and timing of EM, as well as the specific staff and equipment required to achieve the planned activity, are all planned in advance with buy-in from the medical staff, nursing staff and physiotherapists, as well as any other staff specific to achieving that goal.

Patients have reported that during the early phase of critical illness, and particularly the first sessions of EM in ICU, they prefer a paternalistic approach to rehabilitation where the activities and the process of EM are directed by the staff delivering EM [27]. It is important to have one person leading and coordinating the EM to ensure the patient can focus clearly on instructions and to maximise safety [28].

## What Solutions Are Available to Support Implementation of Early Mobilisation in the Intensive Care Unit?

The translation of research evidence into clinical practice remains a challenging aspect of evidence-based care in the intensive care unit [33, 34]. Early mobilisation is no exception with multiple observational studies demonstrating that physical activity levels in the critically ill remain very low [2, 35–37]. However, a number of recent publications provide potential solutions to support evidence translation and implementation of EM into daily clinical practice.

The Society of Critical Care Medicine (SCCM), American Thoracic Society & American College of Chest Physicians (ATS), the German Society of Anesthesiology and Intensive Care Medicine (DGAI) and the New South Wales Agency for Clinical Innovation (ACI) have all recently published clinical practice guidelines (CPGs) which make recommendations related to EM in the ICU [8, 28, 38, 39]. All of these CPGs support implementation of EM based on reviews of the current evidence. The recommendations of these guidelines are summarised in Table 2.3.

Both the SCCM and ATS guidelines utilised the Grading of Recommendations, Assessment, Development and Evaluation (GRADE) methodology for guideline development [40]. This methodology requires a detailed assessment of the quality and certainty of the research evidence underpinning the recommendations including the risk of bias, effect size and consistency between studies with meta-analysis of results undertaken where possible. This detailed analysis revealed that whilst there is a significant body of evidence supporting the potential of EM to improve outcomes such as decreased mechanical ventilation time, improved functional independence at hospital discharge and increased strength, there remain significant limitations to the evidence for EM. There is a lack of Phase 3 evidence from large randomised controlled trials (RCTs) with the evaluation of all relevant outcomes including adverse events. Importantly, a well-powered Phase 3 RCT is required to evaluate long-term safety outcomes including mortality. There is inadequate evidence available to guide recommendations related to dosage, intervention selection or the identification of responders and nonresponders. The contrast in strength of recommendation made by the ACI guideline is likely related to the evaluation of the evidence using the NHMRC levels of evidence which classifies studies based on design only without a detailed assessment of other factors which effect quality.

Whilst there are important limitations to the recommendations provided by existing CPGs, clinicians can utilise these documents to support changes to clinical practice. It is important to recognise that these recommendations are made via expert consensus based on careful evaluation of the risks and benefits in the context of healthcare values and therefore can represent best evidence-based practice despite a lack of high-quality research evidence [41]. Conditional recommendations are considered to apply to most patients, but significant consideration must be given to local healthcare system factors and individual patient conditions and values when implementing these recommendations. Clinicians should consider a range of factors when selecting CPG recommendations for implementation in the local context. Tools such as the Practice Guidelines Evaluation and Adaptation Cycle and the Appraisal of Guidelines Research and Evaluation II (AGREE II) Instrument can be used to identify and select recommendations of high quality and relevance to the local patient cohort and clinical practice environment [42, 43]. Preference may also be given to a CPG based on the needs of the guideline user, for example, the development of a business case compared to a local practice guideline or staff education programme. The resources provided by each guideline are summarised in Fig. 2.1.

In addition to the resources provided by recent clinical practice guidelines, a broad range of published resources are available to support delivery of early mobilisation. These include Hanekom and colleagues [44] algorithms for patient and

**Table 2.3** Summary of the recommendations for early mobilisation from recent clinical practice guidelines

| Publication | Recommendation | Strength | Evidence |
|---|---|---|---|
| SCCM 2018 [8] | "We suggest performing rehabilitation or mobilisation in critically ill adults"<br>Remark: "This recommendation suggests performing rehabilitation/mobilisation interventions over usual care or similar interventions with a reduced duration, reduced frequency or later onset" | Conditional | Low quality |
| ATS 2017 [38] | "For acutely hospitalized adults who have been mechanically ventilated for more than 24 hours, we suggest protocolized rehabilitation directed toward early mobilisation" | Conditional | Low certainty |
| ACI 2017 [28] | "A dedicated physical activity and movement program should be implemented to aid in the recovery of critically ill patients" | NHMRC Grade A | Not specified |
| | "Early physical activity and movement is feasible and safe for critically ill patients and should be incorporated into usual practice" | NHMRC Grade A | Not specified |
| | "All patients admitted to the ICU should be screened on a daily basis for inclusion in a physical activity and movement program … this screening should occur within 24 hours of admission" | NHMRC Grade C | Not specified |
| | "The program, based on the patient's current activity level, should be developed in consultation with a multidisciplinary team" | NHMRC Grade C | Not specified |
| DGAI 2014 [39] | "In principle, early mobilisation should be conducted in all patients treated in intensive care, for whom no exclusion criteria apply" | Recommendation grade A | Evidence level 2b |
| | "Treatment should begin no later than 72 h after admittance to intensive care and be conducted twice daily with a duration of at least 20 min for the length of stay in intensive care. A gradual approach should be aimed for starting with passive mobilisation. In this regard, the development of an algorithm specific to a unit or hospital is recommended" | Recommendation grade B | Evidence level 3 |
| | "A protocol-based approach is recommended for implementing early mobilisation. Active mobilisation should be conducted by at least two qualified staff members; a physiotherapist should be regularly integrated. Sufficient spatial requirements and resources should be kept"<br>"Early mobilisation should be incorporated into a set of measures, which includes the strategy for adapted symptom monitoring of pain, fear, agitation and delirium, as well as for the daily assessment of spontaneous breathing" | Recommendation level A | Evidence level 2b |

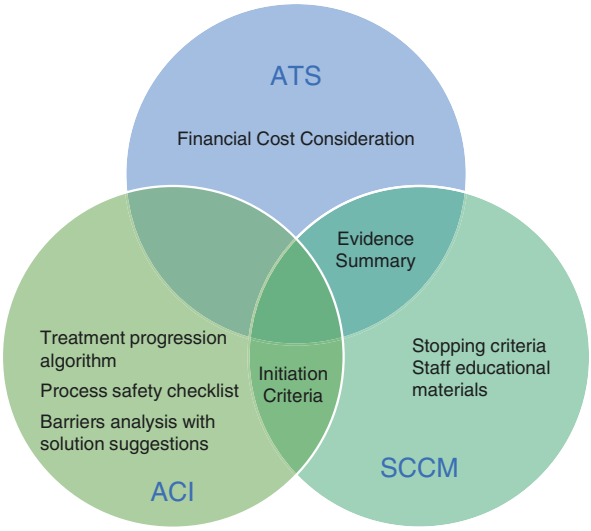


**Fig. 2.1** Implementation resources provided by existing clinical practice guidelines

intervention selection, Hodgson et al. [13] expert consensus on a safety screening traffic light system and the practical guide with mobility planning pneumonic and progression chart by Green et al. [45]. Additionally, many authors have provided early mobility protocols [12, 46, 47]. However, the key limitation to translation of these guidelines and resources into daily practice is the lack of consideration given to the development of strategies to maximise applicability and provision of processes which support staff to implement the recommendations and resources locally in a sustained manner.

Existing studies investigating EM interventions in daily practice via implementation science and quality improvement projects provide important insights into which knowledge translation approaches are effective. A recent review of quality improvement studies implementing early mobilisation of mechanically ventilated patients demonstrated four key themes which related to successful outcomes: managing the change process through strong leadership, designing strategies and interventions to overcome barriers to implementation, multidisciplinary team collaboration and data collection and feedback systems [48]. Other successful strategies identified in the literature include the implementation of early mobilisation interventions within a multifaceted approach such as care bundles to minimise other barriers such as sedation and delirium [49, 50]. Studies demonstrating programmes which can be effectively translated to other institutions and sustain improvements have been based on a structured quality improvement process known as the strategy for translating evidence to practice [51–54]. Key components of this approach include local barriers analysis, development of targeted strategies to overcome these including a variety of educational and executional methods and repeated performance measurement. The final overarching theme of implementation studies is the provision of adequate resourcing of the programme via staffing and equipment, the timing of introducing this resourcing was variable between projects with some introducing additional

staffing to support initial implementation, whilst other utilised positive initial results to motivate redirection of resources for sustainability of the programme. The results of these multicomponent structured quality improvement projects are in contrast to studies investigating single component interventions to improve compliance with early mobilisation which have not shown a positive effect [55]. Figure 2.2 describes the key components clinicians should utilise when developing a local EM research translation approach.

Together with the resources described above, several tools are also available to support the development of these components including:

- Patient Mobilisation Attitudes & Beliefs Survey—Intensive Care Unit (PMABS) [56].
- Core Outcome Measures for Acute Respiratory Failure Survivors [57].
- *Under development*: Physical Rehabilitation Core Outcomes in Critical Illness (PRACTICE) [58].
- The Surgical Intensive Care Unit Optimal Mobility Score (SOMS) [59].
- The ICU Mobility Scale [60].
- The ICU Liberation Resources [61].

## How Will Early Mobilisation Be Delivered in the Future?

New ideas and concepts are being developed and discussed for intensive care, including living ICUs, where the historical technological focus of medicine will be complemented by a patient- and family-centred care approach. Focusing on the future of EM, three key domains are expected to play a major role: regulation, personnel resources and technology and biomedical development.

Currently, EM is recommended by some medical societies [8, 38, 39], is part of quality indicators for intensive care in some countries [62] and is one part of the ICU liberation strategy using the ABCDEF bundle [63]. The results of the TEAM RCT (https://www.teamtrial.org.au, NCT03133377), investigating early active mobilisation in ventilated patients using a published algorithm, will have a major impact on the future directions for EM. If the TEAM RCT provides evidence of a positive effect on mortality or days alive and out of hospital within 180 days, it is likely that in addition to patient advocacy groups, regulatory entities will step in and mandate a protocolised active EM regime. To provide such active and protocolised care, it will be necessary to provide far more resources than that are currently available for EM. Most developed countries already struggle with physical therapy and nursing staffing. A possible solution might be to reduce the number of healthcare providers necessary to mobilise a patient safely. Mobilisation typically needs at least two people; with technology, such as robotic assistance, this might be reduced. For example, tilt tables have been modified to be connected to a robotic mobilisation system [64] so that a critically ill patient stays in a (special) bed that can be attached to and used by a robotic mobilisation system. Since the patient is not

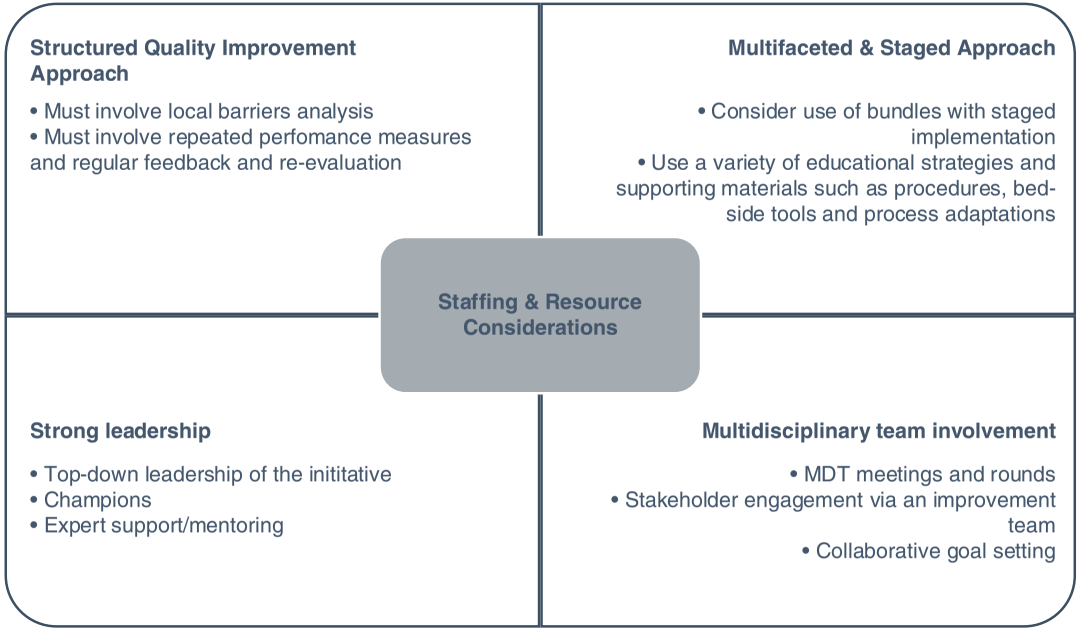


**Fig. 2.2** Key components to a successful EM implementation programme

transferred out of the bed, there is potential for the system to allow one person to complete mobilisation treatments alone. Even then, the system is still limited by the required personnel resources, such as time to set up the system, and the patients' low exercise capacity. Therefore, we should aim to develop systems which require only a single application and can be automatically and repeatedly activated. This could support the neuromuscular system of the patient whilst accounting for the individual training capacity and regeneration phases necessary without further staff supervision of the intervention. Imagine a futuristic advanced exoskeleton or just a suit in contact with the skin with sensors and stimulation capacities.

Besides such technological advances, in the patient- and family-centred ICU, patients would ideally be liberated from sedation to maximise their participation in care and decision-making [38]. They would have the opportunity to be surrounded by their regular social environment, such as family members, to support their psychological well-being and the (self-)healing process. The social construct could be a motivator and allow family to act as therapists by providing EM to the patient. This process already has started locally in some locations, where family members are encouraged to be part of mobilisation sessions, support therapy or provide passive mobilisation to their loved ones.

## How Will Early Mobilisation Be Prescribed in the Future?

Independent of the TEAM RCT results, more questions must be answered to guide clinicians prescribing EM interventions in the future to achieve the greatest impact on patient- and service-centred outcomes and to maximise the efficiency of resource use. Firstly, what is the optimal dose of EM? We have seen that the dose of EM may influence the outcome of our patients following a stroke and the resources needed are dose-dependent [65]. There is an ongoing international collaboration preparing a study to answer this question. Secondly, do patients who have been functionally dependent before the hospital admission benefit from EM in a similar way? Are the pathomechanisms in this cohort the same? Is the goal of EM for such patients to prevent further functional decline? If yes, is the prevention of a decline possible and what resources are necessary to achieve this? Emerging investigation into measures, such as frailty, which allow stratification of cohorts may assist in the identification of responders and nonresponders to interventions such as EM. Finally, what is the impact of staff expertise on the delivery and outcomes of EM interventions? To date, most EM trials have utilised highly experienced staff for delivery of EM treatments. As intervention uptake increases and spreads to centres with minimal exposure to this complex intervention, it will be important to consider the impact of confidence and training on outcomes.

In summary, the coming years will be exciting for EM of critically ill patients. Ideally, the future will hold a clearer perspective for clinicians with the availability of selection criteria for the most appropriate patient cohort. Algorithms need to be developed to identify dosage, monitoring and stopping criteria based on clear

evidence from trials. Key areas for improvement include improved follow-up and an understanding of both the dose–response relationship to EM and the expertise needed to successfully deliver these programmes. This will benefit critically ill cohorts around the globe.

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