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# Mobilisation



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# Mobilisation Matters: Strategies for Efficient Patient Care

Post-Intensive Care Syndrome encompasses long-term physical, cognitive, and mental impairments, impacting patients' quality of life. Early mobilisation is known to improve functionality. However, clinical practice often falls short of guidelines due to barriers like haemodynamic and respiratory instability, staff shortages, and knowledge gaps. Regular multi-professional assessments and educational interventions could enhance safety and implementation.

## Introduction

Intensive care unit (ICU) survivors have emerged as a new cohort within the last decade due to decreasing ICU mortality that is founded on the rapid development of modern medicine (Zimmerman et al. 2013). In this cohort, severe long-term sequelae of physical, cognitive and mental nature became evident and have been summarised under the Post Intensive Care Syndrome (Needham et al. 2012). Patients have classified physical impairments as the most relevant outcome for ICU survivors (Nedergaard et al. 2018). Those physical impairments develop rapidly during the acute phase and manifest as muscle weakness (ICU-acquired weakness (ICUAW)) and muscle atrophy with a loss of 17.7% of muscle mass during the first ten ICU days (Wollersheim et al. 2014; Fazzini et al. 2023). ICUAW develops in 40% of all ICU patients and up to ~80% in patients with risk factors such as multiple organ failure (Appleton et al. 2015; Yang et al. 2018). ICUAW has an immediate impact on ICU length of stay, duration of mechanical ventilation and mortality up to five years after discharge (Hermans et al. 2014; Van Aerde et al. 2020). Physical impairments have also been shown up to five years after discharge with reduced walking distance, reduced endurance capacity (VO2 max), symptoms of fatigue and most importantly, health-related quality of life measured mainly via functionality during daily living (Herridge et al. 2011; Van Aerde et al. 2020; Van Aerde et al. 2021; Morel et al. 2022). Interestingly, muscle strength and muscle mass recover after ICU discharge without an impact on quality of life and might, therefore, represent the best surrogate measure during the acute phase rather than a true casual pathophysiologic rationale (Fan et al. 2014; Dos Santos et al. 2016; Wollersheim et al. 2019).

Mobilisation is the current intervention of choice for addressing the physical impairments and has undergone rapid development with the goal of improving quality of life and functionality of ICU survivors.

## The Current State of Evidence and Recommendations

Protocol-based mobilisation is generally recommended through international guidelines as it has been sufficiently shown to mediate a treatment benefit, i.e. shorter ICU length of stay and improved physical function (Schweickert et al. 2009; Schaller et al. 2016; Schaller et al. 2023). Furthermore, mobilisation reverses muscle atrophy as a pathophysiological hallmark (Wollersheim et al. 2019). As established before, physical impairments develop early during critical illness, as pathophysiological changes have been shown as early as 48 hours after admission (Tankisi et al. 2021). Hence, the early initiation of mobilisation seems plausible and is backed by multiple trials and a meta-analysis showing a therapeutical benefit (Daum et al. 2024). Nevertheless, until today, no uniform definition of early mobilisation exists, and the latest published guideline out of Germany and Austria has defined it as mobilisation within 72 hours of ICU admission based on the available evidence (Schaller et al. 2023). Mobilisation, in general, is a very safe intervention, with a meta-analysis showing adverse events in only 2.6% of mobilisation sessions, and only 0.6% of those adverse events had any consequences (Nydahl et al. 2014). Immobilisation or minimal handling should consequently always be prescribed since contraindications for mobilisation are scarce (Schaller et al. 2023).

## Knowledge Gaps

Even though recommendations for early mobilisation are available, their uptake into daily clinical practice is lacking. Multiple trials over the last decade have shown that out-of-bed mobilisation is especially rare in mechanically ventilated patients. Nydhal and colleagues (2014) found in their point prevalence, including 783 patients, that only 24% of those on mechanical ventilation were mobilised out-of-bed, while Jolley et al. (2017) found that only in 16% of 770 patient-days of mechanically ventilated patients were mobilised out-of-bed. Different reasons (e.g., instability of the patient, lack of knowledge, and staff shortages) have been established as causative for the current mobilisation practice, which is partially incongruent with guideline recommendations. Moreover, there are still open questions regarding the conduction of early mobilisation i.e. dosage and inclusion of devices.

## The Early and Unstable Phase

One major barrier and area of uncertainty is the acute, unstable patient, i.e. their haemodynamic instability or different forms of vascular access, airway or drains, as reported by 50% of the studies included in the review by Dubb and colleagues (2016). This was further underlined by the point-prevalence study conducted by Black et al. (2023), who were able to demonstrate that patients who were mobilised less presented a worse haemodynamic or respiratory status. Furthermore, they outlined that active mobilisation, in particular, is most commonly not performed due to instability. However, mobilisation is a safe intervention (Lang et al. 2020). Paton et al. (2024) demonstrated in their systematic review and meta-analysis, including 67 trials with 7004 patients, that the chance for adverse events was under 3% and that there was no effect on mortality. This confirmed the previous investigation by Nydahl and colleagues (2017), who also found mobilisation to be safe.

To prevent adverse and serious adverse events, adherence to certain safety criteria before and during a mobilisation session, e.g. those published in guidelines or consensus statements, is important (Hodgson et al. 2014; Schaller et al. 2023). Secondly, it is very important to perform daily interprofessional evaluations since different professions have different perceptions of the patients' mobilisation capabilities (Hermes et al. 2020). During those interprofessional assessments, potential hazards and barriers can be addressed, improving the safety of the mobilisation session. Additionally, the involvement of an occupation or physical therapist is a strong predictor for achieving a greater mobilisation intensity (Jolley et al. 2017; Hermes et al. 2020). Lastly, a progressive mobilisation protocol starting with passive mobilisation and working towards active mobilisation is recommended. When adhering to this recommendation, it can cautiously be tested which type of mobilisation the patient can tolerate and which adverse events can be prevented. This recommendation is based on the rationale that even passive mobilisation as part of a progressive protocol has shown benefits, and it could be established in the TEAM trial outlined below in more detail that utilising a top-down approach does not convey any benefit (Investigators et al. 2022; Vollenweider et al. 2022).

## Dosage and Duration of Mobilisation

A crucial aspect, as with every medical therapy, is the appropriate dosage, which is currently unclear. The dosage for early mobilisation is multifactorial and consists of the duration, intensity (especially the level), and frequency. Various observational studies have examined the optimal dose-response relationship. Scheffenbichler et al. (2021) investigated the question of which dose of mobilisation predicts adverse discharge disposition and found that both the duration of mobilisation and the maximum mobilisation level are predictors of an adverse discharge disposition. The study revealed a wide variability in the dose of mobilisation treatment applied, which could not be explained by patients' comorbidity or disease severity. Importantly, a high dose of mobilisation was identified as an independent predictor of patients' ability to live independently after discharge. Similar results were observed in the study by Mazwi et al. (2023) in neurocritical patients. A high dose of mobilisation was associated with a lower likelihood of adverse discharge disposition.

A study by Lorenz et al. (2023) investigated the effects of daily mobilisation for 40 minutes on the functionality of critical illness survivors at ICU discharge. It was demonstrated that a mobilisation duration of over 40 minutes per day, compared to less than 40 minutes, is an independent predictor of improved functional status at discharge from the ICU. This effect was confirmed in three different models evaluating the baseline characteristics of the patients. However, the study also found that the average treatment effect disappeared when parameters such as the level of mobilisation were included in the analysis. This suggests that the highest level of mobilisation achieved during the ICU stay is the critical factor for proper dosing, as a longer duration showed no additional benefits in patients who had already reached high levels of mobilisation. All those investigations indicate that a higher dosage conveys a beneficial effect.

Despite the many positive examples of aiming for a high level of mobilisation, it has been shown that there can still be too much early mobilisation. This discrepancy was particularly evident in the TEAM trial. In this study, the effect of increased early mobilisation (sedation minimisation and daily active physiotherapy) was compared to usual care (mobilisation according to guidelines) in mechanically ventilated patients, focusing on the outcome of being alive and out of the hospital at 180 days. The results showed that increased early active mobilisation did not result in a significantly greater number of days that patients were alive and out of the hospital compared to the usual level of mobilisation in the ICU. However, the intervention was also associated with increased adverse events (Hodgson et al. 2022). Important points to consider are that (1) the control group received already high-quality mobilisation, (2) the intervention focused on active mobilisation, (3) the goal was to start with the highest possible level each day instead of progressing the level during the day and (4) sedation was still the major barrier for mobilisation in both groups. However, if patients do not receive mobilisation, the negative long-term effects on cognition and physical function are evident (Patel et al. 2023).

In their systematic review, Paton et al. (2024) also addressed the association of active mobilisation variables with adverse events and mortality in patients requiring mechanical ventilation in the ICU. They demonstrated that the implementation of mobilisation in the ICU was not associated with an increase in adverse events or mortality. It remains unclear what the optimal level, frequency, and duration of early mobilisation should be. The task of future research will be to resolve uncertainties and gain a better understanding of early mobilisation dosage, maybe in an individualised approach.

## Education

Insufficient knowledge and training have also been shown to be a common barrier to early mobilisation (Dubb et al. 2016). This is underlined by the fact that the knowledge of current mobilisation guidelines led to the selection of higher and more appropriate levels of mobilisation for ICU patients (Hermes et al. 2020). It, therefore, is important to not only focus on the intervention itself but also on its integration into daily clinical practice. Even short training interventions consisting of different teaching formats, such as online lectures, handouts, and bedside teaching, can sufficiently improve the uptake of guideline recommendations into daily clinical practice, as shown by Paul and colleagues (2024). Therefore, the implementation of a new mobilisation protocol or the update of a national or international guideline should always be accompanied by a training intervention.

## Assistive Devices and Robotics

Staff shortages are ever present and have been reported as a common structural barrier (Dubb et al. 2016; Hermes et al. 2020). An effective approach to counter this problem is the use of assistive devices and robotics. Rather than serving as an independent therapy, devices and robotics function as a tool to surmount obstacles to early mobilisation. There are various devices and robotics designed for different phases of intensive care stay that are currently being tested in studies.

### From sitting to standing

Studies by Raurell-Torredà et al. (2021) and Paton et al. (2021) showed that patients who were mobilised at least to a standing position relatively early had a significantly improved health condition after their ICU stay, and it positively impacted the development of ICUAW. However, for critically ill patients, sitting and standing at the edge of the bed can be significantly hindered by insufficient trunk stability and often requires additional support for the patient. This frequently binds several staff members for a single mobilisation session. An innovative approach tailored to support sitting and standing in critically ill patients in the ICU is a sit-to-stand stabiliser. This type of device has promising potential for facilitating earlier and safer mobilisation. It potentially enables patients to be comfortably stabilised in a seated position without leaving the bed, ensuring the highest level of safety for both patients and caregivers. A possible advantage of such a sit-to-stand stabiliser is that it allows patients to safely sit or stand at the bedside without requiring active assistance from healthcare providers. Healthcare professionals can attend to other tasks in the room without compromising patient safety. By reducing the need for continuous hands-on support, a sit-to-stand stabiliser may enhance the effectiveness of earlier mobilisation and promote a more autonomous and dignified patient experience. The clinical benefits of a sit-to-stand stabiliser, including whether it helps patients stand more quickly and its impact on long-term patient outcomes, are currently being investigated (NCT05716451).

### Cycling in the ICU

An excellent example of device-assisted mobilisation, particularly for bedridden patients, is in-bed cycling. This method can be seamlessly and swiftly incorporated into patient care, facilitating early movement and recovery. The primary advantage is that during mobilisation, the patient can perform passive, assisted-active, or active mobilisation independently after setup. This also allows other tasks to be carried out in the patient's room without the nursing or physiotherapy staff needing to be actively involved with the patient. A recently published study by Kho et al. (2024) on the use of early in-bed cycle ergometry in mechanically ventilated patients demonstrated that the use of in-bed cycling was not associated with an increase in adverse events. Thus, they were able to demonstrate that the additional implementation of in-bed cycling is safe. However, the study could not show improvement in physical function three days after discharge from the ICU. Similar findings were observed by Fossat et al. (2018) who investigated whether early in-bed leg cycling combined with electrical stimulation of the quadriceps muscles combined with standardised early rehabilitation would lead to greater muscle strength upon discharge from the ICU. Early in-bed leg cycling exercises did not improve overall muscle strength at the time of discharge from the ICU. Further studies have investigated the long-term effects of in-bed cycling, specifically six months after ICU stay, compared to usual care (Berney et al. 2021; Waldauf et al. 2021). In these studies, no clear clinical benefit for the use of in-bed cycling was demonstrated. This has been investigated on a pathophysiological level, and no effect could be found (Jameson et al. 2023). In conclusion, progressive mobilisation by healthcare providers is the gold standard, and cycling may be considered if mobilisation cannot be provided otherwise (e.g., because of staff shortage).

### New approaches in the ICU: Robotic beds

Mobilisation sessions involving walking represent a significant logistical challenge, in particular, if the patient is still ventilated or on ECMO, which could be addressed through modern robotics. An example is a robotic system that combines infinitely adjustable verticalisation with robot-assisted leg movement therapy. A major advantage is that patients can perform ambulating exercises without having to leave their beds. This specific robotic mobilisation system comprises an external robot that attaches to the patient's bed, facilitating both active and passive movements. The patient can engage in in-bed cycling in a horizontal position, transitioning to a stepping motion when the healthcare provider initiates verticalisation of the bed. An initial pilot study by Lorenz et al. (2024) assessed the feasibility of robotic-assisted mobilisation in COVID-19 patients. The implementation appeared to be safe and feasible, demonstrating that integration into clinical practice was possible. Another study also showed that the use of the robot-assisted leg movement system was feasible, but it required process adjustments and consideration of unit staffing levels, as the intervention did not save staff resources or time (Warmbein et al. 2024). The same research group also examined patient-specific outcomes. There were no statistically significant differences in the duration of mechanical ventilation, ICU length of stay, muscle parameters, or quality of life after three months (Huebner et al. 2024). Overall, robot-assisted mobilisation has been demonstrated to be safe in clinical practice without showing any advantage in terms of saving personnel or time for early mobilisation.

## Outlook: Artificial Intelligence in the ICU

Artificial Intelligence might be an option to address the barrier of current knowledge gaps. It can be employed to develop personalised therapy concepts, providing tailored treatment options for patients. This potential was highlighted in a study by Fuest et al. (2023), where an AI-based learning approach successfully categorised a diverse critical care cohort with significant differences in clinical characteristics and mobilisation parameters. The use of varied mobilisation strategies improved the likelihood of patients being discharged home, allowing for an individualised and resource-optimised approach to mobilisation. In other areas of medicine, AI-based personalised therapy also improved patient outcomes. Buell et al. (2024) utilised machine learning to define oxygenation targets for critically ill patients and showed that this classification had a relation to mortality. This underscores the importance and potential benefits of individualised treatment adjustments in intensive care medicine. Currently, we are at the very beginning of AI development in the clinical setting with missing evidence of clinical benefits. Nevertheless, it is a rapidly evolving and exciting field.

## Conflict of Interest

None.

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