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Rehabilitation during mechanical ventilation: Review of the recent literature

George Ntoumenopoulos[a,b,c,*]

[a] School of Physiotherapy, Australian Catholic University, Sydney, Australia
[b] Physiotherapy Department, St. Vincents Hospital, Sydney, Australia
[c] Physiotherapy Department, Guy's and St. Thomas' NHS Foundation Trust, Kings Health Partners, London, United Kingdom

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Summary Mechanically ventilated patients are at increased risk of developing physical and psychological complications that are associated with prolonged weaning from mechanical ventilation, increased morbidity and mortality. These complications include intensive care unit acquired weakness, delirium and a loss of physical function that may persist well beyond ICU and hospital discharge. Factors such as the requirement for intubation and mechanical ventilation, sedation, systemic inflammation and immobility are associated with the development of these physical and psychological complications. Implementation of rehabilitation in mechanically ventilated patients has been demonstrated to be both safe and feasible and provide benefits in terms of physical and psychological function and assist with weaning from mechanical ventilation. The recent relevant literature on the role of rehabilitation interventions in the mechanically ventilated patient will be discussed.

Implications for Clinical Practice

- Intensive care unit acquired weakness is a common complication in the critical care patient.
- Rehabilitation interventions can be safely delivered within critical care and are associated with improved functional outcomes.

* Correspondence to: School of Physiotherapy, Australian Catholic University, Level 9, 33 Berry Street, North Sydney 2060, Australia.
E-mail address: georgentou@yahoo.com

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- Future research needs to identify the timing of rehabilitation commencement in addition to the type(s) and dosage of rehabilitation required during critical care.
- The role of passive rehabilitation (such as limb range of movement and patient re-positioning) and electrical muscle stimulation especially when patients may be too unwell for mobilisation out of bed requires further investigation.

Introduction

Bed rest is still common in the critically ill patient (Goldhill et al., 2008). However, with increasing survival of the critically ill patients there is now an increased awareness of the physical and psychological complications after discharge from intensive care (Needham, 2008; Truong et al., 2009) that may be related to bed rest during intensive care. Critical illness and mechanical ventilation (MV) can be associated with the development of polyneuropathy and myopathy often termed intensive care unit acquired weakness (ICU-AW) (Hermans et al., 2008). ICU-AW impairs weaning from mechanical ventilation, impairs functional status, prolongs ICU and hospital stay and is associated with increased mortality (Hermans et al., 2008). In the subset of more severe critical illness, survivors of acute respiratory distress syndrome, the impaired functional status and decreased quality of life upon ICU discharge can persist for up to 5-years (Herridge et al., 2011).

Immobility is one of the modifiable risk factors for the development of ICU-AW (De Jonghe et al., 2008) that supports the concept of rehabilitation related interventions in critical care (Gosselink et al., 2008; Hanekom et al., 2011). Rehabilitation interventions includes a range of activities such as bed exercises (passive/active), sitting out of bed (passive and active), cycling in bed and ambulation and have been associated with significantly reduced duration of delirium during critical care (Schweickert et al., 2009), increased ventilator free days (Schweickert et al., 2009) and improved functional outcomes at hospital discharge (Burtin et al., 2009; Schweickert et al., 2009). This review reports on the physical and psychological complications associated with critical illness and mechanical ventilation, the modifiable risk factors for the prevention of these complications and the evidence base for rehabilitation interventions in the mechanically ventilated patient. The search of the PubMed database was undertaken for relevant English-language articles from 2007 to October 2014. In addition, key articles relevant to areas in this review were also obtained through the searching of bibliographies of reviewed articles. The search terms used included: critically ill patients, intensive care, mechanical ventilation, neuromuscular complications, rehabilitation and physiotherapy.

Physical complications associated with intubation and mechanical ventilation

ICU-AW is often clinically diagnosed, but it usually involves the combination of critical illness polyneuropathy (CIP) and critical illness myopathy (CIM) (Hermans et al., 2008). The diagnosis of CIP entails an acute sensory-motor polyneuropathy that affects both the limb and respiratory muscles (Latronico and Bolton, 2011; Latronico and Rasulo, 2010). Whereas, CIM is an acute primary myopathy that is not due to muscle denervation (Latronico and Bolton, 2011; Latronico and Rasulo, 2010). The rates of ICU-AW reported in the critical care literature range from 25% to 100%, with variation depending on patients' characteristics and the method used for diagnosis (Fan, 2012; Latronico and Bolton, 2011). Risk factors for the development of ICU-AW include systemic inflammation, sepsis, multiple organ failure, duration of MV, hyperglycemia, corticosteroid administration and prolonged used of neuromuscular blocking drugs (De Jonghe et al., 2002; Stevens et al., 2007). Not all of these factors are consistently implicated in the literature (e.g. corticosteroids) (Stevens et al., 2007). One of the key factors in critically ill patients is that as they are often in bed and immobile (Fan, 2012) which may be an important variable leading to an increased risk for ICU-AW. Immobility leads to mechanical unloading of muscle resulting in a loss of protein synthesis and accelerated protein degradation, increased oxidative stress and apoptosis leading to muscle atrophy and loss of muscle strength (Chambers et al., 2009; Ginz et al., 2005). In critically ill patients muscle wasting occurs early and rapidly during the first week of intensive care (due to increased protein degradation and reduced protein synthesis) and is more severe in patients with multiple organ failure than patients with single organ failure (Puthucheary et al., 2013). Of note, respiratory muscle weakness also occurs during mechanical ventilation and both limb and respiratory muscle weakness are independently associated with greater failure to wean from mechanical ventilation (De Jonghe et al., 2007). Prolonged inactivity of the respiratory muscles during controlled ventilation modes and even during pressure support ventilation may cause respiratory muscle weakness and ventilator-induced diaphragmatic dysfunction (Demoule et al., 2013; Jaber et al., 2011). Indeed, animal and human studies have demonstrated structural and biochemical changes in the diaphragm during MV such as muscle fibre atrophy and injury, oxidative stress and evidence of proteolysis (Jaber et al., 2011). Respiratory muscle weakness is common and may be a crucial issue determining weaning from mechanical ventilation (De Jonghe et al., 2007). However, the short-term (48-hours) elimination of all respiratory muscle activity with neuromuscular blocking agents may be required early in the course of acute respiratory distress syndrome and sepsis is associated with improved patient outcome (Alhazzani et al., 2013; Marini, 2011; Steingrub et al., 2014) without increasing the risk of ICU-AW.

Rehabilitation during critical care

Early rehabilitation in critically ill patients is recommended to prevent or minimise the physical and psychological