Journal of Physiotherapy 63 (2017) 4–10

Journal of PHYSIOTHERAPY

journal homepage: www.elsevier.com/locate/jphys

Invited Topical Review

Physiotherapy management of intensive care unit-acquired weakness

Carol L Hodgson [a,b], Claire J Tipping [a,b]

[a] Australian and New Zealand Intensive Care Research Centre, Monash University; [b] The Alfred Hospital, Melbourne, Australia

KEY WORDS

Physical therapy
Intensive care
Critical care
Weakness
Early mobilization

[Hodgson CL, Tipping CJ (2016) Physiotherapy management of intensive care unit-acquired weakness. *Journal of Physiotherapy* 63: 4–10]

Introduction

Intensive care unit-acquired weakness (ICUAW) is a common condition in critically ill patients who are mechanically ventilated for prolonged periods of time.[1] Only recently have mechanistic studies shown that muscle atrophy and loss of muscle mass develop rapidly during critical illness – within hours of the patient being intubated and mechanically ventilated.[2] Physiotherapists play an integral role in the prevention and treatment of ICUAW within the intensive care unit (ICU), with studies showing benefit from early mobilisation and inspiratory muscle training for patients in the ICU to improve duration of weaning and functional independence at hospital discharge.[3,4] Most importantly, as survival from ICU increases, physiotherapists will have a greater role in the management of ICUAW after discharge from ICU and hospital.

This review summarises the pathophysiology of ICUAW; the diagnosis during critical illness; the respiratory and musculoskeletal consequences of ICUAW; the burden of ICUAW on survivors of critical illness and their families; strategies to prevent and manage ICUAW, with a focus on specific physiotherapy interventions during critical illness; and future directions for research and practice.

What is intensive care unit-acquired weakness?

ICUAW is a clinical syndrome of generalised muscle weakness that develops while a patient is critically ill, and for which there is no alternate explanation other than the critical illness itself.[1,5] ICUAW is caused by different pathologies, including critical illness myopathy, polyneuropathy or a combination of both.[6–8] It differs from other neuromuscular disorders in the ICU in that facial and ocular muscles are rarely involved, creatine kinase levels are not elevated and demyelination is not a feature.[1] In a recent binational, multicentre cohort study, ICUAW was present in more than 50% of patients at ICU discharge who were mechanically ventilated for greater than 48 hours.[3]

Diagnosis

The diagnosis of ICUAW requires a critical illness, or an illness of a very high severity with prolonged organ support, that is usually associated with a period of protracted immobilisation.[5,9] Key clinical signs that support a diagnosis of ICUAW include the presence of normal cognition, sparing of the cranial nerves, and the presence of symmetrical flaccid weakness. In an official American Thoracic Society Clinical Practice Guideline, ICUAW was reported to be more common in patients with severe sepsis, prolonged mechanical ventilation, or difficulty with liberation from mechanical ventilation.[5] There was no consensus on the approach to diagnosis of ICUAW, including how or when the diagnosis can be made.

Bedside examination of the ICU patient may be complicated by the use of sedatives, neuromuscular blockers and delirium. In clinical practice, physical examination of the muscle groups is usually performed using the Medical Research Council (MRC) Manual Muscle Test, which is dependent on patient effort and cooperation.[10,11] This scale evaluates muscle strength with a score ranging from 0 (no muscle contraction) to 5 (full strength) (Table 1). Physical examination of three muscle groups in each of the upper and lower limbs results in a composite or sum score of the MRC out of 60. Clinically detectable muscle weakness has been defined as 80% of the MRC sum score (ie, a score of < 48 out of a total score of 60). This method has been proven reliable in a cooperative patient.[12,13] Other methods of volitional muscle strength testing that are commonly used in the ICU include handheld dynamometry.[13,14] In a prospective, multicentre cohort study, hand-held dynamometry was used to identify patients with ICUAW and was independently associated with increased hospital mortality.[14]

Pathophysiology

Muscle changes rapidly in the early days of critical illness.[2,15–17] This acute phase response is demonstrated by a reduced ratio of protein to DNA, depressed muscle protein synthesis and a catabolic

http://dx.doi.org/10.1016/j.jphys.2016.10.011

Table 1
Medical Research Council (MRC) manual muscle testing for muscle strength.[9]

MRC Grade	Clinical presentation is graded on patient effort
0	No movement is observed.
1	Only a flicker or a trace of movement is seen or felt in the muscle or fasciculations are seen in the muscle.
2	Muscle can move only if the resistance of gravity is removed. As an example, the elbow can be fully flexed only if the arm is maintained in a horizontal plane.
3	Muscle strength is further reduced such that the joint can be moved only against gravity with the examiner's resistance completely removed. As an example, the elbow can be moved from full extension to full flexion starting with the arm hanging down at the side.
4	Muscle strength is reduced but muscle contraction can still move joint against resistance.
5	Muscle contracts normally against full resistance.

state of proteolysis, which starts within the first days of critical illness and may be accompanied by generalised weakness.[2,18–20] In addition, the interaction of bed rest and critical illness appears to result in more significant muscle loss than bed rest alone.[17,21,22] There is evidence of loss of myosin and membrane excitability. Overall, studies have shown that ICUAW results in decreased muscle protein synthesis, increased muscle catabolism, and decreased muscle mass with decreased force generation. However, there may be significant overlap in biological processes that regulate both muscle mass and nerve contractility, and ICUAW encompasses both critical illness polyneuropathy and myopathy; it therefore may be accompanied by axonal nerve degeneration.[23,24] Additionally, there may be differences between the early and late stages of skeletal muscle dysfunction that should be considered in clinical practice.[20]

Risk factors for intensive care unit-acquired weakness

Bed rest

Both the pathophysiological mechanisms and risk factors are multifactorial in the development of ICUAW in critically ill patients (Box 1). As previously mentioned, in a large multicentre cohort study of 222 patients with acute lung injury, duration of bed rest was the only consistent factor that was associated with the development of ICUAW.[22] It is likely that a combination of both disuse atrophy and inflammation with muscle catabolism results in ICUAW; this challenges the current conventional model of care, in which patients are sedated and immobilised for prolonged periods during the ICU stay.

Sepsis and multi-organ failure

During critical illness, a catabolic state with muscle wasting and systemic inflammation occurs, particularly in patients with sepsis.[25] Two studies have reported a significant association between the presence and duration of systemic inflammatory response syndrome and ICUAW in the first week of ICU.[26,27] Patients diagnosed with sepsis have consistently been identified as having long-term functional disability and should be assessed early in the ICU stay for ICUAW.[28,29] In a landmark publication of patients with acute respiratory distress syndrome (ARDS), multiple organ failure was associated with long-term physical dysfunction and poor health-related quality of life for up to 5 years.[30]

Box 1. Predictors of ICU-acquired weakness.

Intrinsic predictor variables	Intensive care predictor variables
• Age	• Hyperglycaemia
• Medical comorbidities	• Sepsis and inflammation
• Frailty	• Corticosteroids
• Level of independence at admission	• Prolonged use of neuromuscular blockers
• Number of medical comorbidities, including mental health issues and musculoskeletal pathology	• Duration of ventilation
	• Duration of bed rest
	• Duration of ICU stay

ICU = intensive care unit.

Hyperglycaemia

Hyperglycaemia is the most consistently identified risk factor for ICUAW;[31] however, in a large multicentre Phase-III study of intensive glucose control compared with standard care led by investigators in Australia, tight glycaemic control was shown to increase the odds ratio for death.[32] Rather than managing patients with tight glycaemic control, critically ill patients, particularly those with hyperglycaemia, should be assessed for ICUAW and managed with early intervention.

Corticosteroids

Following a prospective cohort study that demonstrated an association between the use of corticosteroids and ICUAW,[8] a number of studies, including a systematic review, have failed to support this association.[31] Despite the current evidence, the use of corticosteroids remains controversial in ICU, with concerns about increased risk of ICUAW.

Neuromuscular blockers

Despite early concerns about the use of neuromuscular blockers in the ICU, several prospective trials, a large, multicentre, randomised, controlled trial and a recent systematic review have failed to show an association between their use and ICUAW.[33,34] Considering the mortality benefit shown in patients with ARDS with the early use (first 48 hours) of neuromuscular blockers to reduce lung injury, the use of these medications should be considered on an individual basis. It is possible that prolonged use of neuromuscular blockers in ICU patients has a different effect to short-term use.

Burden of intensive care unit-acquired weakness

Duration of mechanical ventilation and length of ICU stay

Prolonged duration of mechanical ventilation and ICU stay is a common manifestation of ICUAW. This can occur as a result of weakness in both the diaphragm and the muscles of the chest wall that requires prolonged mechanical support. In a systematic review of ICU patients diagnosed with sepsis, 12 of 13 studies demonstrated that ICUAW was associated with prolonged mechanical ventilation.[25]

Survival and health-related quality of life

Severe weakness is common among survivors of critical illness, and it may persist for years.[22,30] In a recent cohort study conducted in 12 ICUs in Australia and New Zealand, over 50% of patients who received mechanical ventilation for $>$ 48 hours and survived to ICU discharge were found to have ICUAW.[3] The presence of ICUAW at ICU discharge was associated with poor long-term outcome, including increased 90-day mortality compared with patients who did not have ICUAW.[3] This has been confirmed in international cohort studies where increased weakness at discharge was associated with increased risk of mortality at 12 months.[35] ICUAW has also been associated with poor health-related quality of life in cohort studies in the years following critical illness.[35–37] In one cohort study of 13 ICUs in Baltimore, USA, duration of bed rest was the only factor consistently associated with weakness after discharge from hospital. At 2 years, patients with ICUAW had reduced health-related quality of life and physical function