Review Article

Critical illness myopathy and polyneuropathy - A challenge for physiotherapists in the intensive care units

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Abstract

The development of critical patient related generalized neuromuscular weakness, referred to as critical illness polyneuropathy (CIP) and critical illness myopathy (CIM), is a major complication in patients admitted to intensive care units (ICU). Both CIP and CIM cause muscle weakness and paresis in critically ill patients during their ICU stay. Early mobilization or kinesiotherapy have shown muscle weakness reversion in critically ill patients providing faster return to function, reducing weaning time, and length of hospitalization. Exercises in the form of passive, active, and resisted forms have proved to improve strength and psychological well being. Clinical trials using neuromuscular electrical stimulation to increase muscle mass, muscle strength and improve blood circulation to the surrounding tissue have proved beneficial. The role of electrical stimulation is unproven as yet. Recent evidence indicates no difference between treated and untreated muscles. Future research is recommended to conduct clinical trials using neuromuscular electrical stimulation, exercises, and early mobilization as a treatment protocol in larger populations of patients in ICU.

Keywords: Critical illness, myopathy, polyneuropathy, exercises, mobilization, neuromuscular electrical stimulation, muscle atrophy, mechanical ventilation, physical therapy

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Introduction

Critical illness is a medical condition that impairs one or more vital organ system, thus jeopardizing the patients' survival. Patients with chronic critical illness experience profound deterioration of function and quality of life. Considerable published evidence indicates that patients in intensive care units (ICU) have high morbidity and mortality, high costs of care, and a marked decline in functional status. Faced with these issues, health care professionals have been challenged to improve functional status in critically ill patients. Physical therapy professionals have been considered part of the inter-disciplinary team that provides care for critically ill patients. However, published evidence of the effectiveness of physical therapy in this area is limited, one of the reasons being the lack of standard for physical therapy profession in the ICU due to significant differences in practice across hospitals, ICUs, countries staffing levels, training, and expertise.[1-3]

Acquired neuromuscular disorders (NMD) with flaccid weakness in critically ill patients have gained interest among all critical care health professionals. This newly acquired neuromuscular cause of weakness has been found in 46% (95% confidence interval 43%−49%) critically ill patients with sepsis, multi-organ failure or prolonged mechanical ventilation.[4] NMD comprises of critical illness myopathy (CIM) and critical illness polyneuropathy (CIP) or sometimes named CRIMYNE. The acronym CRIMYNE (critical illness myopathy and neuropathy) was coined to emphasize that CIM and CIP often co-exist.[5]

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There is a growing need among physiotherapists to recognize and understand these serious complications and to intervene at an early stage of the ICU stay to limit the consequences of this neuromuscular weakness.

The aim of this study was to highlight features regarding CIM and CIP including clinical features, diagnosis and physical therapy treatment options, like use of neuromuscular electrical stimulation (NMES), exercises and early mobilization. Literature searches were performed using electronic databases including Medline, Cochrane, Highwire Press and Pubmed using key words "critical illness", "physical therapy", mobilization", "neuromuscular electrical stimulation", "critical illness myopathy and polyneuropathy", "exercises", "muscle atrophy", and "mechanical ventilation".

Critical Illness Polyneuropathy

CIP is a sensorimotor polyneuropathy, which was first described by Bolton and colleagues in 1984, and is usually observed in critically ill patients with sepsis and multi-organ failure.[6] CIP can occur as early as 2–5 days in presence of sepsis or as late as 1 week after intubation and mechanical ventilation.[7] In a study conducted by Khan *et al*., patients with severe sepsis developed electrophysiological alterations of the peripheral nerves and muscle within 72 hours from the onset of severe sepsis.[8] In the multicenter Italian CRIMYNE study the median time of the onset of electrophysiological alterations compatible with the diagnosis of CIP was 6 days.[5] Though exact incidence is unknown, CIP seems to be a frequent complication among the most severe ICU patients: 58% in patients with prolonged (>1 week) ICU stay, 63% in patients with sepsis and >10 days ICU stay, 70% in patients with multiple organ failure, 76% in patients with sepsis and multiple organ failure.[9-13] According to Bolton, there are micro-circulatory damages causing impaired peripheral nerve and muscle perfusion. In addition to reduced oxygen supply, the cells are unable to use oxygen and hence to generate an action potential, a condition that has been described as bioenergetic failure.[5]

Clinical signs and symptoms[7,14,15]

- Flaccid, predominantly distal tetraparesis or tetraplegia: Lower limbs more affected than upper limbs.
- Weakness of the respiratory muscles with difficult weaning from mechanical ventilation
- Deep tendon reflexes reduced. or absent or may be sometimes normal
- Sensory loss may be present (difficult to demonstrate in the early ICU phase).

Loss of pain, temperature, and vibrations sense may be demonstrated in the distal limbs.

Diagnosis

Electromyography and nerve conduction studies are the gold standard for diagnosis till date. Electrophysiological signs include a decline in amplitude of sensory and compound muscle action potentials indicating an axonal sensory-motor polyneuropathy. However, electrophysiological studies are difficult to obtain in the ICU due to presence of edema, inadequate voluntary muscle contraction and electrical intereference in the ICU.[14,15]

Critical Illness Myopathy

William Osler in the 19th century was the first one to describe "rapid loss of flesh" in patients with prolonged sepsis.[16] The term CIM describes an acute primary myopathy causing muscle weakness and paralysis in critically ill patients. However, it was in the 2nd half of the 20th century when CIM was described for the first time as a distinct pathological entity in modern medicine.[17] Lefaucher *et al* conducted a study to find out the origin of ICU-acquired paresis by direct electrical stimulation and concluded that there was evidence of neuropathy and myopathy in 57% and 83% of the patients, respectively.[18] Latronico N *et al* conducted a first time systematic study to describe CIMI and CIP in critically ill patients.[19] In a cohort study by Koch *et al* in 53 patients, it was observed that CIM was more frequent (68%) than CIP (38%)[20] CIM describes those myopathies with pure functional impairment and normal histology (acute quadriplegic myopathy) as well as those with atrophy and necrosis. It is important to note that CIM is a primary myopathy and not secondary to muscle denervation. A definite diagnosis of CIM requires a muscle biopsy.

However, based on the muscle biopsies, three sub-types have been identified.[21] They are:

Critical illness myopathy

Here changes are often small and accompany CIP affecting both types of muscle fibres (type 1and type 2). CK values are often normal with good prognosis.

Thick filament myopathy

This is associated with selective loss of myosin filaments with creatinine kinase (CK) values elevated. It is often associated with medications like corticosteroids and neuromuscular blocking agents. It has a better prognosis than necrotizing myopathy.

Acute necrotizing myopathy of intensive care

This rare type of myopathy has a poor outcome with

elevated serum CK and history of being non-septic with high doses of corticosteroids, neuromuscular blocking agents or both.

Clinical signs and symptoms [17]

1. Proximal and distal muscle weakness
2. Sensations spared
3. Reflexes decreased

EMG and nerve conduction studies can confirm the diagnosis.

Physiotherapy approach in patients with CIP and CIM

Percutaneous neuromuscular electrical stimulation

Percutaneous neuromuscular electrical stimulation (NMES) is a method to induce skeletal muscle growth as well as to enhance strength and endurance capacity for patients who are not able to perform active exercises preventing loss of muscle mass. Clinical trials have shown positive results with short term effects on skeletal muscle metabolism and muscle mass in critically ill patients, although not invariably. NMES is well tolerated and may preserve the muscle mass of critically ill patients, including patients with chronic obstructive pulmonary disease and congestive heart failure. It may be considered to be an alternative treatment to active exercises, which does not require patient cooperation. Use of NMES has shown to increase muscle strength and reduce the number of hospital days for transfer from bed to chair. Long term use of NMES has shown to have positive effect on tissue healing including redistribution of interface pressures away from the pressure regions with an increase in local blood flow. Regular NMES may increase regional vascularization, hence prevent bed sores in spinal cord injury patients.[22-28] However, though NMES is a promising technique, definite evidence of efficacy is still lacking. The role of electrical stimulation is unproven as yet. Recent evidence indicates no difference between treated and untreated muscles.[29] Hence, more clinical trials in future are required to strengthen the supporting evidence.

Exercises

Therapeutic exercises (both active and passive) are aimed to improve function and reduce disabilities and complications like muscle shortening, contractures, and deformities. Studies have shown that more than one third of patients with prolonged stay of two or more weeks in ICU had at least two functionally significant joint contractures clearly indicating immobility as a major reason for development of contractures and a contributing factor for muscle wasting and muscle weakness in critically ill patients.

Therapeutic exercises may begin as soon as the patient is hemodynamically stable to prevent prolonged hospitalization and associated immobilization risks and may be one of the key factors for patients' recovery. Exercises in ICU offer well established physical and psychological benefits and additionally reduce oxidative stress and inflammation due to increased anti-inflammatory cytokines production. Exercises schedules like trunk control, passive, active and resistive exercises with therabands and weight cuffs, upper and lower limb strengthening exercises, functional training, walking, mobilization with frequent positional changes, respiratory physiotherapy have shown beneficial effects in terms of clinical outcome and early weaning.[1-3,30-33]

Early mobilization /kinesiotherapy

Early mobilization or kinesiotherapy has shown muscle strength improvement in critically ill patients providing faster return to function, reducing weaning time and length of hospitalization. Ross in 1972 described a technique for augmenting ventilation during ambulation in patients receiving mechanical ventilation. He also described the therapeutic benefits of physical activity including psychological well being and increased muscle strength.[32] Schhweickert was the first to demonstrate the efficacy of early physical and occupational therapy in critically ill patients. This study demonstrated that this strategy could be safely used in the ICU, and resulted in better functional outcomes at hospital discharge, shorter duration of delirium, and more ventilator-free days compared with standard care.[33] Early ambulation with walker accommodating ventilator with a bench for patient rest has facilitated weaning with minimal problems associated with prolonged bed rest. Perme and Chandrashekhar developed a 4 phase protocol, which included various interventions including education, positioning, bed mobility training, transfer training, walking program and exercises including passive, active and resistive exercises in each phase. Patients were allowed to proceed with the next phase only if they cleared the first phase of the protocol.[1,34,36-38]

Early activity has proved to be feasible and safe in respiratory failure patients and also a mobility protocol for acute respiratory failure patients has proved to shorten the hospital stay. Improved function can have an encouraging effect on patients' psychological well being, quality of life and to shorten weaning period from mechanical ventilation. As Milbrandt rightly points "we may someday see early activity as an integral part of the care in critically ill patients"[39]

Conclusion

Early physical and occupational activity in the ICU is safe, feasible, and has a measurable, significant effect

on reducing the time to recovery of daily life activities. NMES is a promising treatment, but definitive evidence of efficacy in the critically ill patients with CIM, CIP, and muscle weakness is still lacking. Multicentre trials using larger sample size may prove beneficial in formulating a general protocol using NMES, exercises, and early mobilization programs in critical care setting.

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