

## Methods of assessment of muscle weakness acquired in ICU: a narrative description

### Métodos de avaliação da fraqueza muscular adquirida na ICU: uma descrição narrativa

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#### **ABSTRACT**

**Introduction:** With scientific and technological advances, the survival of critically ill patients has increased over the years. However, some patients require prolonged invasive mechanical ventilation (IMV), which can increase the length of stay in the intensive care unit (ICU) and lead to ICU-acquired muscle weakness (ICUAW). There are several tools to diagnose ICUAW, however, most of them depend on patient collaboration, and often, due to sedation, this becomes unfeasible. **Objective:** To describe the ICUAW assessment instruments in critically ill patients. **Methodology:** A bibliographic search was carried out in PubMed, MedLine (International Literature and Health), LILACS (Latin America and the Caribbean in Health Sciences) and Cochrane databases between 1995 and December 2019 using the keywords: muscle weakness, muscle strength and intensive care unit. **Conclusion:** The assessment of muscle weakness is of great importance to verify the health status of critically ill patients admitted to the ICU and to

guide them towards the most appropriate treatment plan. Thus, it is essential for the physical therapist to know the various instruments for assessing muscle weakness acquired in the ICU.

**Keywords:** muscle strength, muscle weakness, intensive care unit.

## RESUMO

**Introdução:** Com os avanços científicos e tecnológicos, a sobrevivência dos pacientes gravemente doentes aumentou ao longo dos anos. Contudo, alguns pacientes requerem ventilação mecânica invasiva prolongada (VMI), o que pode aumentar o tempo de permanência na unidade de cuidados intensivos (UCI) e levar à fraqueza muscular adquirida na UCI (ICUAW). Existem vários instrumentos para diagnosticar a ICUAW, no entanto, a maioria deles depende da colaboração do paciente, e muitas vezes, devido à sedação, esta torna-se impraticável. **Objectivo:** Descrever os instrumentos de avaliação do ICUAW em pacientes gravemente doentes. **Metodologia:** Foi realizada uma pesquisa bibliográfica nas bases de dados PubMed, MedLine (Literatura e Saúde Internacional), LILACS (América Latina e Caraíbas em Ciências da Saúde) e Cochrane entre 1995 e Dezembro de 2019 utilizando as palavras-chave: fraqueza muscular, força muscular e unidade de cuidados intensivos. **Conclusão:** A avaliação da fraqueza muscular é de grande importância para verificar o estado de saúde dos pacientes gravemente doentes admitidos na UCI e para os orientar para o plano de tratamento mais adequado. Assim, é essencial para o fisioterapeuta conhecer os vários instrumentos para avaliar a fraqueza muscular adquirida na UCI.

**Palavras-chave:** força muscular, fraqueza muscular, unidade de cuidados intensivos.

## 1 INTRODUCTION

In recent decades, the main causes of hospitalization of critically ill patients in intensive care units (ICU) were respiratory and cardiovascular system involvement, sepsis, neurological, renal and gastrointestinal tract changes (FEIJÓ et al. 2006; DAMASCENO et al. al. 2006).

Scientific and technological advances in intensive care, such as the use of invasive mechanical ventilation (IMV), have significantly increased the survival of these patients (Damasceno et al. 2006). However, some develop the need for prolonged IMV, in addition to an indication of movement restriction until the hemodynamic picture is stabilized (Koukourikos, 2014). These factors can increase the length of stay in the ICU, promote a worse prognosis, increase the risk of nosocomial infection, decrease the functional status of the patient and also provide muscle weakness acquired in the ICU (ICUAW) (OLIVEIRA, 2011).

ICUAW is recognized as a frequent complication in critically ill patients, without the presence of previous neuromuscular disease. It is characterized by a diffuse, symmetrical, bilateral muscle weakness, manifesting as flaccid tetraparesis with hyporeflexia or areflexia (Koukourikos, 2014; Oliveira, 2011). It has a multifactorial cause, which includes muscle atrophy, due to immobility, sepsis, multiple organ dysfunction, acute respiratory distress

syndrome (ARDS), malnutrition, toxicity of medications such as sedatives, neuromuscular blockers, in addition to corticosteroids (KOUKOURIKOS, 2014; NEEDHAM, 2008). ; GARNACHO-MONTERO, 2005; JONGHE, 2009).

Its development affects 30% to 60% of patients admitted to the ICU, and can make weaning from IMV difficult, reduce functional capacity, quality of life, increase mortality, and these factors can persist for up to 5 years after hospital discharge. (Puthuchery, 2014; Herridge, 2011; Hermans, 2015). In view of this, minimizing the effects of AMF-ICU should be one of the priorities in the treatment of critically ill patients.

To this end, it is necessary to use specific instruments that address the assessment of functionality, strength, and inflammation, the latter using inflammatory markers of muscle degradation in ICU patients, in order to identify patients with greater potential for the development of AMF-ICU and, thus, adopt early measures for its treatment or even preventive measures to avoid its appearance.

Therefore, it is essential to carry out studies that seek further elucidation of these assessment instruments. In this sense, we present a non-systematic narrative review in order to expose the AMF-ICU assessment instruments as well as the muscle function biomarkers.

## **2 MUSCULAR ASSESSMENT INSTRUMENTS**

There are several instruments for muscle assessment, among them, the measurement of muscle mass, muscle strength, physical performance tests, functionality tests, electrophysiological tests and even biomarkers (PAFTI, 2014).

In a hospital setting, especially in ICUs, muscle assessment may be limited due to the inability of patients to cooperate in carrying out the tests, mainly due to sedation (França, 2012). Therefore, it is necessary to use instruments that are more specific and sensitive to the public in question.

### **2.1 ULTRASONOGRAPHY**

Ultrasonography (USG) is a method that can be used to measure muscle mass and has been shown to be sensitive in identifying changes in muscle density during critical illness (Puthuchery, 2013). It is a simple, portable instrument that is widely available in ICUs, is quick to perform, is free of ionizing radiation, and can be performed at the bedside by trained professionals (Connolly, 2015). Puthuchery et al., observed that patients with multiple organ dysfunction showed loss of muscle mass during ICU stay, reaching an average reduction of 17% in quadriceps cross-sectional area on the 10th day of admission. (Puthuchery, 2013). Studies

point to the importance of risk stratification of patients with loss of peripheral muscle mass in order to optimize clinical management (PUTHUCHEARY, 2009; PUTHUCHEARY, 2013).

## 2.2 ANTHROPOMETRY

Anthropometry is also an instrument for assessing muscle mass. It refers to the use of body weight and the measurement of lengths and circumferences of body structures. Its use in critically ill patients, however, is questionable due to its low reliability, sensitivity and also due to the body edema, often present in these patients (PARRY, 2015).

## 2.3 MEDICAL RESEARCH COUNCIL

Currently, the Medical Research Council (MRC) is one of the most known and used instruments worldwide for the assessment of peripheral muscle strength, being the gold standard for the diagnosis of ICUAW. This scale assesses the voluntary muscle strength of 6 muscle groups (shoulder abductors, elbow flexors, wrist extensors, hip flexors, knee extensors, and ankle dorsiflexors) on each side, rating them between 0 - no visible contraction, 2 - active movement, but without overcoming gravity; 3- active movement, overcoming gravity; 4- active movement, “overcoming” gravity and partial resistance; 5- active movement, overcoming gravity and total resistance (Kasotakis, 2012; Kennouche, 2021). The scale has an ordinal characteristic and generates a total score (sum of each individual muscle score) ranging from 0 (paralysis) to 60 (normal strength). A score below 48 was arbitrarily used for the diagnosis of ICUAW, with a score below 36 used to indicate severe muscle weakness (KENNOUCHE, 2021).

It is easy to apply, reproducible and has a high predictive value in patients with ICUAW. To date, intra-investigator reliability has never been reported in ICU patients. However, good to excellent intraclass correlation coefficients (ICCs) have been described and observed in other pathologies, such as Duchenne muscular dystrophy and radial palsy. Inter-investigator reliability of the MRC sum score was considered good to excellent in ICU patients. However, lower ICC values were presented when considering the assessment of individual muscle groups, indicating that this method is less reliable to assess the strength of a single muscle group.(KENNOUCHE, 2021).

Although this scale is classified as the gold standard, so that it can be applied and measured, the patient's cooperation is necessary, who in most cases admitted to the ICU are under the effect of sedation. Still, other factors may influence the results, such as: pain, swelling or limitation of range of motion. In addition, the scale itself has limitations, such as, for example, grade  $\leq 3$  uses only gravity as a reference, while grade  $>3$  refers to muscle contraction against

non-standard and subjective resistance, without accurate measurements of resistance (KENNOUCHE, 2021).

## 2.4 DYNAMOMETRY

Another method for assessing peripheral muscle strength is the dynamometer. Voluntary strength measurements can be performed on the upper and lower limb muscle groups in a short time (approximately 15 minutes) and still require no complex training for the investigator. (KENNOUCHE, 2021).

Different experimental protocols have been used to quantify voluntary strength through the dynamometer, however, measurements are not fully standardized. Most studies follow the recommendations of the American Society of Hand Therapists, performing the test in the sitting position, while others use the supine position (taking into account the inability to maintain a stable vertical posture). (KENNOUCHE, 2021)..

This is an instrument with a numerical quantification variable, it presents normative values and also a cut-off point for FMA-ICU (PAFTI, 2014; Cruz-Jentoft, 2010). The ability of the palmar dynamometer to diagnose UTI-AMF was investigated and the cutoff values adopted were <11kg in men and <7kg in women. Intra-investigator reliability of palm dynamometer measurements was presented as excellent in ICU patients (ICC = 0.86-0.92), and inter-investigator reliability was also good to excellent in ICU patients (ICC = 0.92). 88-0.97). In addition, the MRC scores were positively correlated with the strength values of this equipment, which could be a substitute for the MRC to diagnose ICUAW (KENNOUCHE, 2021).

Therefore, patients who have  $MRC \geq 3$  may be using this equipment to obtain accurate strength values. However, studies that address this issue do not bring with them the criteria used to define the state of awakening, which is an important point, since patient collaboration is substantially necessary for the tests to be carried out. Generally, the first measures of voluntary strength are tested after a median stay in the ICU ranging from 3 to 16 days. In this context, in order to anticipate the diagnosis of AMF-ICU, non-volitional force measurements may be an attractive alternative in order to provide an earlier characterization of neuromuscular function in sedated patients (KENNOUCHE, 2021). The high cost of the equipment and the need for patient cooperation are limiting factors for its use. (PAFTI, 2014).

## 2.5 FUNCTIONALITY SCALES

There are several scales for assessing functional status, however few are specific and sensitive for the assessment of critically ill patients. Six scales were developed specifically for

application in ICU patients, and two were translated into Portuguese, one of them the Perme Scale (*Perme Intensive Care Unit Mobility Score*) (CASTRO-AVILA, 2015; DENEHY, 2013; CORNER, 2013; KAWAGUCHI, 2016; KASOTAKIS, 2012; HODGSON, 2014; THRUSH, 2012).

## 2.6 PERME MOBILITY INDEX IN THE ICU

The Perme Mobility Index in the ICU was developed to measure the mobility situation of critically ill patients admitted to the ICU, from the ability to carry out commands to the distance covered in 2 minutes. The sequence of items was based on the progression of activities routinely used by physical therapists in patient mobilization. The score is derived from 15 items grouped into 7 categories: mental status, potential mobility barriers, functional strength, bed mobility, transfers, gait, and resistance (KAWAGUCHI, 2016).

The final score ranges from 0 to 32, with each of the 15 items reaching a maximum of 2 to 4 points and providing a total score that reflects the mobility situation at a given moment in time. A high score indicates greater potential for mobility barriers and little need for assistance, while low scores indicate more mobility barriers and a greater need for mobility assistance. (KAWAGUCHI, 2016).

## 2.7 BIOMARKERS

There are also biomarkers for the assessment of muscle function, including stand out to serum creatine kinase (CK) and insulin-like growth factor 1 (IGF-1). In addition to these markers, tumor necrosis factor  $\alpha$  (TNF- $\alpha$ ), a pro-inflammatory cytokine, has a strong relationship with the presence of sarcopenia (THE VILLAGE-FUNES, 2008; MAIZ, 2005; DOUGLASS, 1992; COAKLEY, 1993; FOSCHINI, 2007).

The CK is a specific musculoskeletal enzyme of paramount importance in the assessment of muscle function. It is described as the best indirect marker of muscle tissue damage (FOSCHINI, 2007). Elevated levels of this enzyme have been reported in critically ill patients with AMF-UTI (AVILA-FUNES, 2008; MAIZ, 2005; DOUGLASS, 1992; COAKLEY, 1993; FOSCHINI, 2007).

IGF-1 is a marker of muscle trophism, responsible for maintaining muscle mass. Its fall decreases the recruitment of satellite cells in muscle tissue and protein synthesis. It leads to an increase in the production of inflammatory mediators, such as pro-inflammatory cytokines, including TNF- $\alpha$ , and of inflammatory markers produced by hepatocytes that accelerate muscle catabolism (Zembroń-Łacny, 2014; Kim, 2014; Pierine, 2009). No high levels of TNF- $\alpha$  can

play an important role in protein degradation and apoptosis in muscle cells (Katz, 2004). The relationship of IGF-1 and TNF- $\alpha$  in patients with AMF-ICU are still not well elucidated.

### **3 CONCLUSION**

The assessment of muscle weakness is of great importance to verify the health status of critically ill patients admitted to the ICU and to guide them towards the most appropriate treatment plan. Thus, it is essential for the physical therapist to know the various instruments for assessing muscle weakness acquired in the ICU.

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