



REVIEW

Application and effects of neuromuscular electrical stimulation in critically ill patients: Systematic review



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KEYWORDS

Intensive care units;
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Electric stimulation
therapy;
Muscle weakness;
Meta-analysis

Abstract

Objective: To investigate the applications and effects of neuromuscular electrical stimulation (NMES) in critically ill patients in ICU by means of a systematic review.

Materials and methods: Electronic searches were conducted in the databases Medline, CINAHL, Cochrane Central Register of Controlled Trials, Web of Science, Embase, ProQuest Health and Medical Complete, AMED, and PEDro. The PEDro score was used to assess the methodological quality of the eligible studies.

Results: The search yielded a total of 9759 titles and nine articles satisfied the eligibility criteria. These studies showed that NMES can maintain or increase muscle mass, strength and volume, reduce time in mechanical ventilation and weaning time, and increase muscle degradation in critically ill patients in ICU. Two studies allowed a meta-analysis of the effects of NMES on quadriceps femoris strength and it showed a significant effect in favor of NMES in the Medical Research Council (MRC) Scale (standardized mean difference 0.77 points; $p=0.02$; 95% CI: 0.13–1.40).

Conclusions: The selected studies showed that NMES has good results when used for the maintenance of muscle mass and strength in critically ill patients in ICU. Future studies with high methodological quality should be conducted to provide more evidence for the use of NMES in an ICU setting.

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PALABRAS CLAVE

Unidades de Cuidados Intensivos;
Cuidados Críticos;
Terapia de estimulación eléctrica;
Debilidad muscular;
Meta-análisis

Aplicaciones y efectos de la estimulación eléctrica neuromuscular en pacientes en estado crítico. Revisión sistemática**Resumen**

Objetivo: Investigar las aplicaciones y los efectos de la estimulación eléctrica neuromuscular (EENM) en pacientes en estado crítico en la UCI a través de una revisión sistemática.

Materiales y métodos: Se hicieron búsquedas electrónicas en las bases de datos MEDLINE, CINAHL, Registro Cochrane Central de Ensayos Controlados, Web Of Science, Embase, ProQuest Health and Medical Complete, AMED y PEDro. La escala PEDro se utilizó para evaluar la calidad metodológica de los estudios elegibles.

Resultados: La búsqueda arrojó un total de 9.759 títulos, y 9 artículos cumplían los criterios de elegibilidad. Estos estudios demostraron que la EENM puede mantener o aumentar la masa muscular, la fuerza y el volumen, reducir el tiempo de ventilación mecánica y el tiempo de destete, y aumentar la degradación muscular en pacientes en estado crítico en la UCI. Dos estudios permitieron un metaanálisis de los efectos de la EENM en la fuerza del cuádriceps femoral y mostraron un efecto significativo a favor de la EENM en la escala Medical Research Council (diferencia media estandarizada de 0,77 puntos; $p=0,02$; IC 95%: 0,13-1,40).

Conclusiones: Los estudios seleccionados mostraron que la EENM tiene buenos resultados cuando se utiliza para el mantenimiento de la masa y la fuerza muscular en pacientes en estado crítico en la UCI. Futuros estudios con alta calidad metodológica deben llevarse a cabo para proporcionar más pruebas para el uso de la EENM en la UCI.

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Introduction

Critically ill patients in intensive care units (ICUs) are subject to various complications resulting from the underlying disease and from being immobilized.¹⁻³ A few examples of these complications are systemic inflammation, atelectasis, metabolic and vascular dysfunction, joint contracture, pressure ulcers, and loss of muscle mass.¹⁻³ The reduction in muscle mass is one of the most debilitating complications in critically ill patients and it hinders their recovery after discharge from ICU due to loss of function.^{4,5} Many factors contribute to muscle mass reduction in the critical patients, e.g. use of medicines, presence of sepsis, prolonged mechanical ventilation (MV), and bed rest.^{1,6,7} One study investigated the effects of 7 days of restricted bed rest in healthy individuals and found a significant reduction of 3% in thigh muscle volume using magnetic resonance imaging.² Therefore, preventing loss of muscle mass in critical patients is one of the main objectives of ICU professionals.⁴ Several therapeutic measures are employed to that end, including range of motion exercises, positioning, and resisted exercises.⁴

One of the techniques used in ICUs to stimulate muscle function is neuromuscular electrical stimulation (NMES). It is widely used in the rehabilitation of patients who need to maintain or increase muscle mass, strength and function, and it has shown promising results in the rehabilitation of immobilized muscles.^{8,9} By definition, NMES is the application of non-invasive sensitive electrical stimulation that causes muscle contraction independent of the patient's effort, i.e. without the need for neural stimuli for the recruitment of muscle fibers.¹⁰ However, there is no consensus on whether NMES alone can increase muscle strength. Nevertheless, some positive results from the technique have

been found when it was applied to the muscles of individuals with spinal cord injury.¹¹⁻¹³

Thus, NMES can be used both in clinical practice and in a hospital setting to increase muscle mass and strength and to increase tolerance to future exercise.¹⁴ For patients in ICU specifically, NMES has been suggested to improve microcirculation and to minimize the deleterious effects of prolonged bed rest, thereby preventing the development of neuromuscular complications after recovery from the underlying disease.¹⁵ Because patients in ICU are extremely debilitated, the use of NMES must have a solid theoretical basis that is grounded on quality studies so that the team involved in the treatment can safely apply the technique.¹⁰ Therefore, the aim of the present study was to investigate the applications and effects of neuromuscular electrical stimulation in critically ill patients in intensive care by means of a systematic review.

Materials and methods

This systematic review was carried out in accordance with PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) recommendations¹⁶ by five investigators, two of whom have large experience in conducting systematic reviews.

Eligibility criteria

For this systematic review, we included randomized and quasi-randomized controlled trials that assessed the effects of non-invasive NMES applied to lower and/or upper limbs of critical patients in ICU. No limit was placed with regard to time of publication or original language. The studies that used NMES outside ICU or in individuals under age of 18 were

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