HOSPITAL UNIVERSITÁRIO
HUPE
PEDRO ERNESTO

Artigo de revisão

Whole body vibration on intensive care unit: Narrative review

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Abstract

Introduction: Whole body vibration (WBV) has been used in several clinical settings, showing potential benefits. However, its application in critically ill patients in the Intensive Care Unit (ICU) is still unknown. Objectives: We aim to investigate the use of WBV in an ICU setting, looking for potential benefits and effects. Method: We searched papers in the PubMed and PEDro databases using terms related to "whole body vibration" and "intensive care". Results: Only two papers were found. Both focused on assessing the safety and feasibility of WBV in critically ill patients, along with its metabolic responses. Conclusion: WBV is a feasible and safe rehabilitation tool and can be used in critically ill patients. WBV has the potential to prevent and/or treat muscle weakness in these patients.

Keywords: Whole body vibration; Exercises; Intensive Care Unit.

Resumo

Vibração de corpo inteiro na unidade de terapia intensiva: revisão narrativa

Introdução: A vibração de corpo inteiro (VCI) vem sendo aplicada em diferentes condições clínicas, demonstrando potenciais benefícios. Entretanto, sua aplicação em pacientes críticos na Unidade de Terapia Intensiva (UTI) ainda permanece pouco conhecida. Objetivos: Investigar o uso da VCI no ambiente de UTI, buscando potenciais efeitos e benefícios. Métodos: Buscou-se artigos nas bases de dados PubMed e PEDro utilizando os termos "*whole body vibration*" e "i*ntensive care*". Resultados: Foram encontradas apenas duas publicações, ambas com foco na avaliação da segurança e viabilidade e respostas metabólicas da VCI em pacientes críticos. Conclusão: A VCI mostrou-se uma ferramenta de reabilitação segura e viável em pacientes críticos. A VCI tem potencial para prevenir e/ou tratar a fraqueza muscular nesses pacientes.

Descritores: Vibração de corpo inteiro; Exercício; Unidade de Terapia Intensiva.

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Revista HUPE, Rio de Janeiro, 2018;17(1):39-43

Recebido em 24/08/2018. Aprovado em 19/10/2018.

Resumen

Vibración corporal total en la unidad de cuidados intensivos: revisión narrativa

Introducción: La vibración corporal total (VCT) se ha utilizado en varios entornos clínicos, mostrando beneficios potenciales. Sin embargo, su aplicación en pacientes críticamente enfermos en la Unidad de Cuidados Intensivos (UCI) aún se desconoce. Objetivos: Nuestro objetivo es investigar el uso de VCT en la UCI, buscando posibles beneficios y efectos. Métodos: Se buscaron artículos en las bases de datos PubMed y PEDro utilizando términos relacionados con "*whole body vibration*" y "*intensive care*". Resultados: Solo se encontraron dos publicaciones. Ambos se centraron en evaluar la seguridad y la viabilidad de VCT en pacientes críticamente enfermos y las respuestas metabólicas. Conclusiónes: VCT es una herramienta de rehabilitación factible y segura que puede usarse en pacientes críticamente enfermos. WBV tiene el potencial de prevenir y/o tratar la debilidad muscular en estos pacientes.

Palabras clave: Vibración corportal total; Ejercicios; Unidad de Cuidados Intensivos.

Introduction

Whole-body vibration (WBV) generated by a platform is described as an external stimulation inducing a vertical sinusoidal oscillation vibration. The central mechanism of WBV is related to the tonic vibration reflex that induces involuntary and monosynaptic-triggered muscle contractions.[1,2] Several studies have been demonstrating beneficial effects of WBV in different populations, from athletes[3] to chronic[4-5] and critically ill patients.[6-7]

Patients in the Intensive Care Unit (ICU) are exposed to many risk factors to muscle wasting and intensive care unit-acquired weakness (ICU-AW), such as sepsis, multiple organ failure, immobility, hyperglycemia, and use of corticosteroids and neuromuscular blocking agents,[8-10] leading to longer ICU and hospital stay, higher morbimortality and worst long-term prognosis.[8,11-12]

Early mobilization of critical patients reduces the length of mechanical ventilation and ICU and hospital stay,[13-14] especially in those who are able to participate in active physiotherapy. On the other hand, many patients remain inactive and can not evoke muscle contraction due to the use of invasive devices or sedation.[15]

To these patients, the use of external devices to stimulate muscle contractions must be considered. Some investigations with electrical muscle stimulation (EMS) in critically ill patients showed promising results.[16-17] However, the application of EMS is time-consuming and effectiveness is still inconsistent.[18]

As an alternative, the use of WBV for muscle activation in critically ill patients at ICU has been studied.[6-7] WBV helps to maintain muscle mass and strength in healthy volunteers undergoing bed-rest.[19] These benefits correspond exactly to the needs of critically ill patients and may increase functional outcomes at ICU discharge.[6]

With this review, we aim to investigate the use of WBV at ICU setting, searching for potential benefits and effects.

Methods

Research strategy

We searched the papers in the PubMed and PEDro databases on August 14th, 2018. The search was performed using the following terms (i) "whole body vibration", (ii) "whole body vibration" and "critical care", (iii) "whole body vibration" and "intensive care", (iv) "whole body vibration" and "ICU", and (v) "whole body vibration" and "critically ill".

Concerning the databases verified, (a) PubMed includes around 25 million citations for biomedical literature from MEDLINE, online book and life science journals (http://www.ncbi.nlm.nih.gov/pubmed), and (b) PEDro is a free Physiotherapy Evidence Database comprising over 30000 systematic reviews, clinical practice guidelines, and randomized trials in physiotherapy (http://www.pedro.org.au).

Inclusion and exclusion criteria

As it is shown in Table 1, we did not find any publication with keywords association in the PEDro database. In the PubMed database, only a few studies were found.

To be included in this review, all studies had to investigate the WBV in critically ill patients during ICU stay and be published in English. Studies with hospitalized patients, but not at ICU, were excluded. Duplicated publications were eliminated. Two of the authors read six abstracts potentially eligible for this review and for those that met the inclusion criteria the full texts were accessed.

Table 1. Number of publications in the PubMed and PEDro databases

Keywords	PEDro	PubMed
"whole body vibration"	302	1979
"whole body vibration" and "critical care"	0	7
"whole body vibration" and "intensive care"	0	10
"whole body vibration" and ICU	0	2
"whole body vibration" and "critically ill"	0	5

Results

Only two publications investigated the application of WBV in critically ill patients at ICU.[6-7] Descriptions of the type of platform, the patients, the training characteristics, measures, and outcomes are shown in Table 2.

Discussion

WBV is widely applied in different clinical and healthy contexts. Nevertheless, it seems that this type of exercise is still unknown and unused in the ICU setting. Concerning this, the number of publications found in searched databases is extremely small.

Considering WBV as a new tool to be applied in in critically ill patients, publications focused on demonstrate its safety and feasibility.[6-7] No research was found with the clinical application or aiming to investigate the effects of WBV in these patients.

Concerning vital signals changes during WBV, Boeselt et al.[6] found a slight increase in heart rate (HR) and blood pressure (BP), without changes in peripheral oxygen saturation (SaO_2). However, all potential effects related to the therapy were minor and reversible within a few minutes. Wollersheim et al.,[7] found no significant differences in HR, mean BP, systolic blood pressure, and SaO_2 from baseline during WBV. In addition, WBV increased respiratory rate and did not significantly influence intracranial pressure levels.[7]

WBV did not alter cardiac output, stroke volume, nor stroke volume range in critically ill patients, while cardiac power output showed a significant, but clinically irrelevant, increase compared with baseline. Increased oxygen uptake levels and enhanced carbon dioxide production were also observed, demonstrating increased energy expenditure. Stable ventilation state (indicated by unchanged partial pressure of oxygen (pO_2) and partial pressure of carbon dioxide (pCO_2), acid-base state (pH, bicarbonate, base excess), and oximetry for the patients during WBV were noted.[7]

Mechanical stretch and the reflex mechanism of the peripheral nerves are the main physiological principles behind WBV, which may promote around 1000 muscle contractions per minute, leading to increased muscle strength and mass.[20] So, muscle activation generated by WBV is the possible mechanism for the increased energy expenditure found by Wollersheim et al..[7] It can be confirmed by steady-state levels for pO_2, pCO_2, pH, bicarbonate, and base excess, which were also found.

WBV was associated with an increase of potassium serum levels compared with baseline, while the sodium concentrations remained unchanged. Furthermore, changes in glucose and lactate levels were not observed.[7] Potassium levels probably increased due to muscle contraction. However, WBV does not result in substantial anaerobic muscle activity, which could be demonstrated by lactate level increase. This is providential, for anaerobic muscle activity would presumably not benefit critically ill patients.

Decreased myosin synthesis and increased myosin degradation is a mechanism to development of ICU-AW.[21] Vibration increased synthesis and decreased activation of the ubiquitin-proteasome pathway with myostatin and Atrogin-1 suppression, in vitro.[22] These findings indicate that vibration could have an impact on preserving muscle in critically ill ICU patients.

Physiotherapy and early mobilization have been shown to be safe and feasible through several clinical studies.[13,14,23,24] Considering that critically ill patients are often not ready for active exercises, WBV might be a possibility to evoke muscle activation within a protocol-based physiotherapy and mobilization plan and may be continued when patients are awake.[7]

Based on the publications found, we conclude that WBV is a feasible and safe rehabilitation tool and can be used in critically ill patients, exhibiting no harm to the patients. WBV has the potential to prevent and/or treat muscle weakness in these patients. However, further randomized trials are needed to evaluate the potential beneficial effects of WBV in the ICU setting.

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Table 2. Data about the devices of the oscillating platform, the subjects, the frequency, and the amplitude used in the oscillating platforms

Reference	Subjects	Clinical characteristics	Position	Consciousness	Platform	Training description	Measures	Outcomes
Boeselt et al.[6]	12 ICU patients (5 males, 7 females), 41.8 ± 19.7 years and 12 healthy male volunteers, 31.3 ± 6.6 years.	Pulmonary and cardiac patients	Supine, inclined by 25º. The device was attached to the foot of the bed.	RASS ¬-1 to 0	GalileoTM (Novotec Medical, Pforzheim, Germany)	First step: vibration was performed alone for 3 min (24 Hz). Second step: after 1 min of rest, WBV with a dumbbell was added, with a vibrating dumbbell mounted on the bed trapeze.	Systolic and diastolic pressure, heart rate and peripheral oxygen saturation.	Feasibility and safety
Wollersheim et al.7	19 (11 males, 7 females), 54 (52/59) years	Neurosurgical patients mechanically ventilated for > 48 hours with an estimated ICU stay of at least 7 days.	Supine. Vibration device placed under the patient's feet, with resistance to the end of the bed. The patient's hips and knees were flexed at about 20°.	RASS -4 to 0	APromedi, Vibrosphere® (n = 12) BGalileo, home-ICU® (n = 7)	Sessions took 15 minutes, with 9 minutes of clear vibration time. Two different devices were used: (A) synchronous vibration (26 Hz, 9 x for 1 min); (B) side alternating vibration (24 Hz, 3 x for 3 min)	Heart rate, mean arterial pressure, systolic blood pressure, oxygen saturation, cardiac output, stroke volume, stroke volume range, cardiac power output, intracranial pressure, serum blood samples, blood gas analyses, energy expenditure, oxygen uptake, and carbon dioxide production	Feasibility, safety, and metabolic response

ICU – Intensive Care Unit. RASS – Richmond Agitation Sedation Scale. WBV – whole body vibration.

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