Electrical Muscle Stimulation (EMS) Improve Functional Independence in Critically Ill Patients

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Abstract: Objective. This study was designed to investigate the effects of electrical muscle stimulation (EMS) on strength of muscle groups stimulated and improvement in functional independence in critically ill patients. Methods. 134 subjects were recruited among the patient admitted in multidisciplinary intensive care units and randomly divided in to control and EMS group. Patients unable to understand or speak English and or Hindi due to language barrier or cognitive impairment prior to admission, unable to transfer from bed to chair at baseline prior to hospital admission, Patient with known history of primary systemic neuromuscular disease were excluded from study. Results. EMS group patients achieved higher MRC scores than controls in knee extensors and ankle dorsiflexors.Independence level was higher in EMS group Conclusions. EMS application constitutes a promising means of muscle strength preservation and early mobilization which can directly reflects the gain in functional independence post ICU discharge in critically ill patients.

Key words: electrical muscle stimulation, muscle strength, CIPNM, CIM, functional independence

1. INTRODUCTION

Weakness that is acquired during hospitalization for critical illness is increasingly recognized as common and important clinical problem. Weakness acquired in the intensive care unit (ICU) and related acquired neuromuscular dysfunction occur in a large percentage of critically ill patients and are associated with increased morbidity and mortality. Critical illness polyneuromyopathy (CIPNM) is an acquired neuromuscular disorder observed in survivors of acute critical illness. It is characterized by profound muscle weakness and diminished or absent deep tendon reflexes and is associated with delayed weaning from mechanical ventilation suggesting a possible relation between limb and respiratory neuromuscular involvement. In addition, the syndrome is associated with prolonged hospitalization and increased mortality. The diagnosis of CIPNM requires a reliable bedside muscle strength examination and depends on patient's cooperation and maximal effort. Several risk factors have been identified including systemic inflammatory response and sepsis, medications such as corticosteroids and neuromuscular blocking agents, inadequate glycemic control, protracted immobility, hypalbuminemia, Gram-negative bacteremia and severity of organ dysfunction. Thus, looking for the potentially reversible risk factors and subsequent adjustment of therapy are so far advocated as preventive measures to decrease the risk of CIPNM.

A very few of studies available suggesting the treatment and prevention of critical illness myopathy these includes intensive insulin therapy, optimal glycemic control and minimized use of neuromuscular blocking agents, high dose and prolong use of corticosteroids.

1.1 OBJECTIVE OF THE STUDY:

The objective of this study is to investigate whether electrical muscle stimulation (EMS) will improve functional independence in critically ill patients.

Our experimental Hypothesis was that “EMS would beneficially affect muscle functional independence and will improve functional independence in critically ill patients.
2. MATERIAL AND METHODS

2.1 SUBJECTS:
The 134 subjects were recruited among the patient admitted in multidisciplinary intensive care units during the study period.

2.2 EXCLUSION CRITERIA:
Unable to understand or speak English and or Hindi due to language barrier or cognitive impairment prior to admission, unable to independently transfer from bed to chair at baseline prior to hospital admission (based on detail history taken from caregivers. Patient with known history of primary systemic neuromuscular disease, vascular events, organ transplant, intracranial process that is associated with localizing weakness, transferred from another ICU after >2 consecutive days of mechanical ventilation, amputation of lower extremities, any limitation of life support, pregnancy, age under 18 years, obesity, technical obstacles that did not allow the implementation of EMS such as bone fractures, skin lesions and, end-stage malignancy were excluded from our study.

2.2 DESIGN OF STUDY:
The study employed a randomized single blind controlled experimental study design consisting of two group experimental group and control group. Subjects were randomly assigned either to experimental group or to control group everyday the ICU patient admission register were observed and within 24 hour the assessment were done, each time when a patient met the criteria for inclusion a random number were picked up between 1 to 10 using sealed envelope method if it were an odd number than the subject were assigned to experimental group similarly if it even number were obtained the subjects were assigned to control group.

2.4 INTERVENTION
EMS was implemented on knee extensors, tibialis anterior and of both lower extremities. Patients received daily sessions. After skin cleaning, rectangular electrodes (90 × 50 mm) were placed on motor point of targeted muscle. The stimulator (Unistim, HMS medical system) delivered biphasic, symmetric impulses of 50 Hz, 100 μsec pulse duration, 12 seconds at intensities able to cause visible contractions. The duration of the session was 30 minutes each muscle group. EMS sessions were continued until ICU discharge, both group were getting routine physiotherapy included the passive movements, active assisted movements and chest physiotherapy.

2.5 OUTCOME MEASURES:
Primary Outcome Measures were the score of Barthel index, it is reliable and valid outcome measure used to assess functional independence.

Secondary Outcome Measures were lower extremity strength, at ICU discharge, of 2 bilateral muscle groups which were stimulated measured by MMT using a composite Medical Research Council (MRC) score.

3. RESULTS AND DISCUSSION
All continuous variables were presented by mean. The statistical significance of P value was set at 0.05.

One-way repeated measures analysis of variance (ANOVA) was made to compare MRC Grading and Barthel index score between-group.

Two hundred and thirty-eight patients were admitted to our multidisciplinary ICU during the eight-month study period and 104 patients fulfilled the exclusion criteria or stayed in the ICU less than 48 hours. The study population consisted of 134 patients of which these patients, 70 were randomly assigned to the EMS group and 64 to the control group. 6 patients from EMS group and 1 patient from control died or were discharged from the ICU before the second measurement.

3.1 RESULTS
MRC muscle grading score of muscle group being stimulated were for left knee extensors were control group mean 3.49 and EMS group mean 3.91 (p = 0.0187), right knee extensors control group mean 3.69 and EMS group mean 3.87 (p = 0.0387), left ankle dorsiflexors control group mean 3.78 and EMS group mean 3.91 (p = 0.04), right ankle dorsiflexors were observed as follows mean control group mean 3.37 and EMS group mean 3.3.46 (p = 0.0587) found.

Barthel index score of control group was (mean) 68.6 and EMS group (mean) 71.9 and found significant between groups (p = 0.010).

Graph 1: Showing the mean and significance level of two group of left and right knee extensor.
3.2 DISCUSSION

The main finding of our randomized controlled study is that EMS of lower extremities seems to preserve the muscle strength of critically ill patients as assessed with MRC muscle strength grading system. EMS of lower extremities applied to critically ill patients upon admission is associated with a lesser degree of muscle strength loss of these patients as assessed with MRC muscle strength grading system. Barthel index score were higher in EMS group and the patient of EMS group were more independent.

Electrical stimulation has been used to increase strength and endurance in partially and fully paralyzed muscle. It has been used for peroneal nerve stimulation \cite{10,11}, the restoration of shoulder movement \cite{12}, recovery of tendonesis grip \cite{13}, and in the use of an upper arm prosthesis \cite{14}. Electrical muscle stimulation (EMS) has been used as an alternative to active exercise in patients with chronic heart failure (CHF) \cite{15} and chronic obstructive pulmonary disease (COPD) \cite{16,17}. Many of these patients, even those who are clinically unstable, experience severe dyspnea on exertion, which can prohibit the regular application of conventional exercise training, considered necessary for an integrated therapeutic approach. In a recent systematic review, EMS implementation in most of the selected controlled clinical trials produced significant improvements in muscle strength, exercise capacity and disease-specific health status \cite{18}. Recently, an study identified an acute systemic effect exerted by EMS on peripheral microcirculation of critically ill patients \cite{19}. Specifically, after performing a 45-minute session of EMS on the lower extremities, an improvement in the microcirculation of the thenar muscle as assessed by near infrared spectroscopy technique was observed.

EMS, as a possible substitute to aerobic and resistance exercise training in severe CHF and COPD patients, has been shown to improve muscle performance, aerobic exercise capacity, and disease-specific health status \cite{9–11}.

4. CONCLUSIONS
EMS exercise induces beneficial effects in muscle strength of ICU patients. These effects mainly concern muscle groups directly stimulated, but there is also evidence of effects in muscle groups not stimulated. EMS application constitutes a promising means of muscle strength preservation and early mobilization which can directly reflects the gain in functional independence post ICU discharge in critically ill patients.

5. CLINICAL RELEVANCE & LIMITATION
EMS is an alternative method of exercise causing minimal discomfort to patients who are not able to perform any form of physical exercise, as is often the case in critically ill patients. It is a limitation of this study that it did not evaluated the follow up stage and upper extremities function. Further studies are needed to explore the possible role of EMS as a tool for preserving the muscle strength and gain in functional independence post ICU discharge with longer follow up evaluation, the muscle properties and preventing CIPNM in critically ill patients and to define which patients would benefit most from this intervention.

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CONFLICT OF INTEREST
Authors declares that they have no conflict of interest.

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REFERENCES


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