International Journal of Hospital Research 2021, 10(3)
http://ijhr.iums.ac.ir
Research Article

Neuromuscular stimulation program for ICU patients

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Abstract

Background and objective: Physical deficiency is associated with reduced cognitive capacity and diminished quality of life as a result of extended muscle failure and Intensive Care Unit-acquired weakness. Neuromuscular electrical stimulation (NMES) has become an alternative to exercise in chronically ill patients. Based on the available evidence, we aim to evaluate the efficacy NMES program for ICU admitted patients.

Methods: The present research is a retrospective case-control study in a multi-center study testing an NMES program for ICU admitted patients. In the present study, sampling was based on the census method and, 74 people were in the control group and 74 people were in the group receiving the NEMS program. This program was piloted in 3 months in the hospital. Patients in the case group got exposure to 45 min per day for 10 days after being 7 days admitted in ICU, a Synchronized impulse at a frequency of 30 Hz on the quadriceps. To assess the effect of the NMES program effect on Quadriceps, the MRC score was used at the discharge time. Also, ICU length of stay, daily GCS, mechanical ventilation duration were recorded. Statistical tests of independent T-test and Chi-square were used to assess the data. P-value under 0.05 was considered significant.

Results: The mean age in the NMES group and the control group was 53.24 ± 12.1 and 57.24 ± 15.3, respectively, but there was no statistically significant difference in the distribution of mean age between the study groups (P> 0.05). In the NMES group, 23 patients (31.08%) and in the control group, 24 patients (32.43%) were female. In the NMES group, 31.08% of patients had muscle weakness at discharge time and the number of these subjects in the NMES group was significantly lower than the control group as 32.43% of the control group had muscle weakness (p = 0.014). The mean days of MV duration in NMES and control groups were 12.8 ± 3.1 and 11.7 ± 2.7 days, respectively (p> 0.05). based on the trend analysis, the mean GCS score in the control and case groups had no significant difference (p> 0.05).

Conclusion: We conclude that the NMES program can prevent the muscle weakness of patients discharged from the ICU, while the implementation of this program doesn't reduce the duration of hospitalization of patients in the ICU.

Keywords: NMES program, ICU, muscle weakness, length of hospitalization

Background and objective

Muscle loss in critical illness has been described as a significant health problem that can lead to chronic muscle weakening, hinder rehabilitation, and decrease the physical activity and quality of life of patients. Neuromuscular electrical stimulation (NMES) has been proposed as an alternative to physical exercise in ICU discharged patients[1]. Muscle failure of ICU patients is in specific, higher than those of other patient groups in the for the first 2–3 weeks[2]. Recent research shows that Intensive Care Unit Acquired Weakness (ICU-AW) can develop within hours of mechanical ventilation and is visible in 25–100 percent of patients who have been ventilated for more than 7 days[3]. Seventy percent of patients with chronic pulmonary disease admitted to ICU reported a substantial decrease in quadriceps muscle strength. NMES has been described as an alternative to active exercise in ICU-discharged patients. NMES is a non-invasive procedure that activates the muscle without active involvement and can preserve the function of the skeletal muscle[4].

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Recent studies in ICU discharged patients have shown that NMES can increase muscle cross-sectional area and strength and regain muscle function by decreasing oxidative muscle stress[5]. Regular NMES with aggressive limb movements dramatically increased muscle strength and substantially decreased transition time to the chair. These results indicate that there could be a possible use of NMES in mechanically ventilated patients following ICU discharge[6]. In this study, the results of an NMES program which was conducted on ICU admitted patients, were compared with another health care center that had not any NMES program for ICU admitted patients in the same city in Iraq.

Methods

Study design

The present study is a retrospective case-control study assessing a protocol of NMES for ICU admitted patients, in a multi-center study. The study was carried out following the Declaration of Helsinki principles. The study was approved by the local human research ethics committee of both hospitals of Hawler teaching hospital and Al Mowasat Private Hospital.

Sampling:

Subjects were recruited among ICU admitted patients for more than 24 hours in 2 ICUs in Iraq. Inclusion criteria were subjects of the hospital with the intervention of NMES, with the age of 18 to 85 years old, who themselves or their families confirmed to participate in the study and receiving NMES were included in this study. Sampling was based on the census method. Exclusion criteria were patients who were admitted to ICU due to trauma, cerebral, and other neurological problems, due to the possible neuromuscular dysfunctions that may affect their muscular functions. Patients requiring surgical treatment during ICU care and patients with known pregnancy or lactating women were excluded. Patients who were going to be discharged sooner than 14 days were excluded.

The Control group was an age-sex matched group of patients, with the age of 18 to 85 years old, who confirmed to participate in the study. The Control group was selected from the second hospital without any NMES program and just got routine nursing care.

NMES program:

This program was piloted in 3 months in the hospital. Patients in the case group got exposure to 45 min per day for 10 days after being 7 days admitted in ICU, a Synchronized impulse at a frequency of 30 Hz on the quadriceps;

For the NMES of the quadriceps, the following parameters were used: Aussie current, synchronized impulse at a frequency of 50 Hz, 1 s pulse increase period, 8 s “on” (muscle contraction) period, 1 s pulse decrease period, and 30 s “off” (disconnection) period. After the skin was waxed and cleaned, a channel with two electrodes was applied to each vastus medialis, another channel with one electrode was applied to each vastus lateralis, and a third channel was applied to each rectus femoral[7].

Study outcomes:

To assess the effect of the NMES program effect on Quadriceps, the MRC score was used at the discharge time. Also, ICU length of stay, daily GCS, mechanical ventilation duration were recorded. On the scale of MRC, the strength varies between 0 (plegic) and 60 (normal strength) points. A score below 48 indicates muscle weakness.

Data analysis:

Data were collected using a checklist. Groupes were matched if there were no statistically significant differences in terms of the type of disease, age, and sex. Data were represented as mean ± standard deviation for continuous data and n(%) for categorical data. Statistical tests of independent T-test and Chi-square were

used to assess the data. P-value under 0.05 was considered significant.

Results

The demographic information of the studied patients can be seen in Table 1. In the present study, the mean age in the NMES group and the control group was 53.24 ± 12.1 and 57.24 ± 15.3, respectively, but there was no statistically significant difference in the distribution of mean age between the study groups (P> 0.05). In the NMES group, 23 patients (31.08%) and in the control group, 24 patients (32.43%) were female. The most common disease was sepsis in both the NMES group and the control group, with 68.92% in the NMES group and 56.76% in the control group, but there was a statistically significant difference in the prevalence of none. Metabolic, cardiovascular and respiratory diseases were not present between the two study groups (P> 0.05). In the NMES and control groups, 14.86% and 17.57% of patients had cardiovascular disease, respectively. In the group receiving the NMES program, 12.6% of patients had metabolic diseases and 4.05% had respiratory diseases. In the control group, 16.22% of patients had metabolic diseases and 17.57% had cardiovascular disease. Like the NMES group in the control group, respiratory diseases with a prevalence of 9.46 had the lowest prevalence (Table 1).

Table1. Demographic information of the study groups LINK Excel.Sheet.12 "Book1" "Sheet3!R9C4:R15C8" \a \f 5 \h * MERGEFORMATX

		NMES group n=74	Control group n=74	p-value
Age, years		53.24±12.1	57.24±15.3	0.371
female, n(%)		23 (31.08)	24 (32.43)	0.971
Disease type	Sepsis	51(68.92)	42(56.76)	0.651
	Metabolic	9(12.16)	12(16.22)	
	Cardiovascular	11(14.86)	13(17.57)	
	Respiratory	3(4.05)	7(9.46)	

In the continuation of the study, we examined the MRC score in the study groups. Our results showed that the mean MRC score in the NMES group and the control group was 53.12 ± 5.2 and 50.48 ± 6.9, respectively, while there was no statistically significant difference between the two study groups (p> 0.05). In the NMES group, 31.08% of patients had muscle weakness and the number of these people in the NMES group was significantly lower than the control group so that 32.43 people had muscle weakness (p = 0.014). The mean days of MV duration in NMES and control groups were 12.8 ± 3.1 and 11.7 ± 2.7 days, respectively (p> 0.05). The mean length of hospital stay in the ICU in the NMES group was lower than the mean length of hospital stay in the control group. The mean length of hospital stay in the NMES and control groups was 23 ± 2.7 and 26 ± 4.9, respectively, but there was no statistically significant difference between the study groups (p> 0.05) (Table 2).

Table 2. evaluation of MRC score, having Muscle weakness, MV duration and, ICU length of stay between study groups.

	NMES group n=74	Control group n=74	p-value
MRC score, mean ± SD	53.12±5.2	50.48±6.9	0.475
Muscle weakness, n(%)	1 (31.08)	8 (32.43)	0.014
MV duration, days, mean ± SD	12.8±3.1	11.7±2.7	0.179
ICU length of stay	23±2.7	26±4.9	0.057

GCS score changes in control and NMES groups can be seen in Fig 1. We examined changes in the GCS scale of patients in study groups over 30 days. The results of this study show that there were no significant differences among the groups, in terms of the daily GCS score (Fig 1).

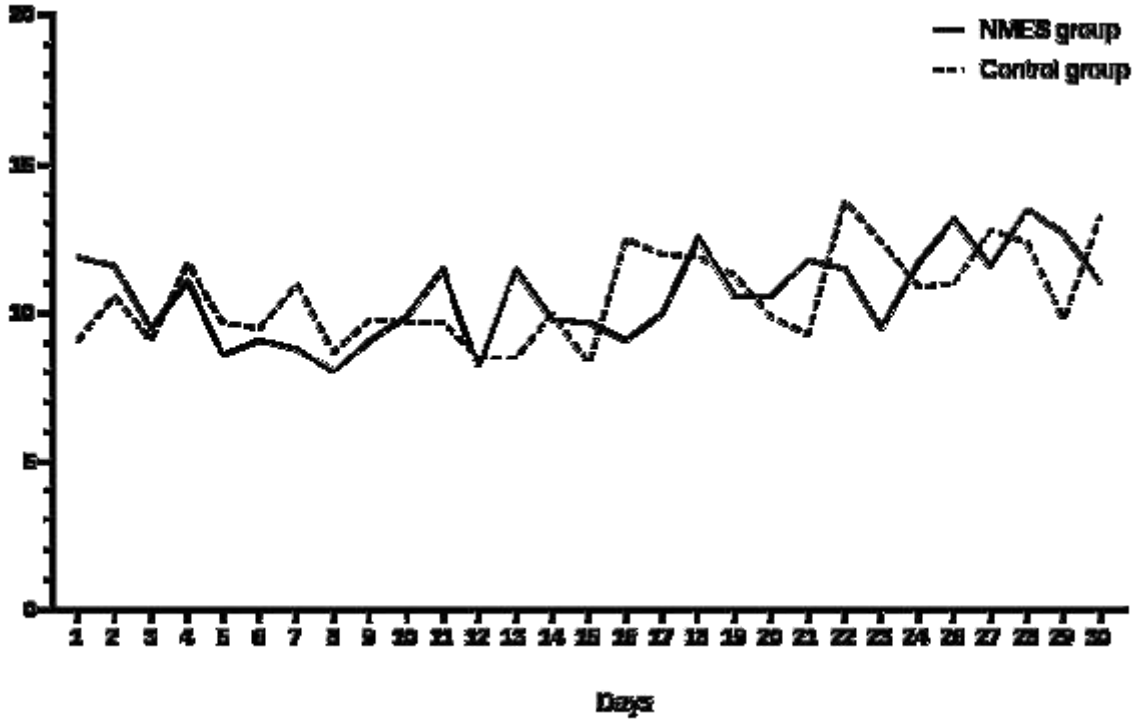

Figure 1. The trend of GCS score changes in the study group

Discussion:

The current study showed that the NMES program can prevent the muscle weakness of patients discharged from the ICU, while the implementation of this program doesn't reduce the duration of hospitalization of patients in the ICU, MV duration, and GCS score.

The lower muscle weakness seen in our study could be attributed to the NMES effect on pain of the muscle. Studies have shown that NMES can also offer substantial relief from persistent back pain after discharge from the ICU. NMES uses high-intensity electrical stimulation elicits intermittent contraction and relaxation of proximal muscle fibers; is commonly used for physical therapy and muscle development following discharge from the ICU[8]. Animal research indicates that NMES can relieve pain

by inducing the release of endogenous analgesics, as well as vasoactive substances influencing blood flow and probably temperature. It is also likely that NMES decreases pain by muscle toning and the avoidance of disuse of atrophy and muscle degeneration often associated with chronic myofascial pain[9]. Also, the decreased rate of muscle weakness in patients discharged from the ICU in our study may be a result of muscle atrophy. NMES is useful in the treatment of weakened muscles[9,10] as it can sustain muscle protein synthesis and avoid muscle atrophy during extended immobilization periods[11]. ICU-based NMES has recently been adopted for the care of ICUAW because it does not require strong patient participation, has an immediate systemic beneficial impact on muscle microcirculation[12], and tends to have certain physiological and functional benefits to critically ill patients[13]. Given the possible use of NMES in patients with limited ability to participate in voluntary muscle function, there is an immediate need to examine the evidence for the use of NMES in ICU discharged patients[14]. Neuromuscular electrical stimulation applied to the normal treatment, relative to regular care alone or placebo stimulation, was associated with increased muscle-strength outcomes in ICU discharged patients with mild to good data[14]. While our study was a pilot one; it shows that NMES benefits would worse for preventing muscle diseases after ICU.

NMES has a possible role to play in a preventive action against ICUAW. Compared to other recovery techniques, the unique features of NMES are that it is comparatively cost-effective, does not require patient participation (can be extended to sedated patients) or healthy cardiac or respiratory activity, can be done within the first few days of discharge from ICU and induces major core effects, both acute and chronic[15], which may also lead to the development of NMES.

Conclusion

While our study showed beneficial effects on the number of patients experiencing muscular weakness at the end of ICU care; more types of neuromuscular interventions which are subject specified will be needed to develop a national physiotherapy program for ICU admitted patients.

Conflict of interests

None.

Authors' contributions

The authors are the same

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Please cite this article as:

Shereen Ismail Hajee . Neuromuscular stimulation program for ICU patients.. Int J Hosp Res. 2021; 10 (3).