Feasibility of neuromuscular electrical stimulation in critically ill patients

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INTRODUCTION

- Outcome survival rate of critically ill patients has improved over the last decades.
- In some cases respiratory and multi-organ failure in ICU leads to immobility, muscle weakness, and atrophy.
- ICU acquired weakness (ICU-AW) is often associated with prolonged mechanical ventilation and increased mortality.
- Upon discharge ICU-AW may persist.
- Early exercise training in critically ill patients receiving mechanical ventilation is safe and beneficial for respiratory and limb muscles.

BACKGROUND

- Often critically ill patients may not be able to tolerate or participate in active exercise or muscle training.
- Neuromuscular stimulation (NMES) may be a potential intervention applied to help prevent further muscle atrophy and strength.
- Previous studies showed inconclusive results of NMES due to various factors: patient population, presentation, swelling, medication use, and myopathy.
- Previous studies have not analyzed the quality of contractions during sessions involving NMES in ICU patients.

PURPOSE

- Investigate the feasibility and safety of NMES of the quadriceps femoris muscle in acute critically ill patients by assessing the quality of muscle contraction.
- Identify factors that can interfere with the quality of contraction.
- Monitor NMES safety.

MATERIALS & METHODS

- 50 patients >18 years of age who stayed at least 3 days in the ICU were enrolled.
- Excluded patients with pre-existing NM disorders & conditions.
- 50% of the patients were responders.
- Patients with sepsis, edema, and those receiving vasopressors were more frequently classified as non-responders.
- Patients admitted to the medical ICU were less likely to be responders compared to patients admitted to the surgical intensive care unit.

RESULTS

- The patients’ average ICU length of stay was 15 days.
- 50% of the patients were responders.
- Patients with sepsis, edema, and those receiving vasopressors were more frequently classified as non-responders.
- Patients admitted to the medical ICU were less likely to be responders compared to patients admitted to the surgical intensive care unit.

DISCUSSION

- A statistically significant difference was found for the type of contraction between session 1 and session 5.
- No patient had a negative response in session 1 that changed to a positive response in session 5.
- 22% of the patients changed from a positive response in session 1 to a negative response in session 5.
- The possibility to elicit an adequate contraction could not be predicted by the NCS and EMG.
- An inverse relationship was found between the level of edema and type of contraction.

CLINICAL SIGNIFICANCE

- This study identified critically ill patients having sepsis, edema, or receiving vasopressors as less likely to respond to NMES with an adequate quadriceps femoris contraction.
- NMES is a safe intervention to be administered in the ICU.

CONCLUSION

- NMES is a modality used to preserve muscle mass and strength.
- Efficiency of PT can be increased by using NMES to control type II muscle fiber atrophy.
- The application of NMES in critically ill patients is attractive during the first week of ICU stay.
- PT can provide patient/caregiver education about the importance of physical activity in ICU to decrease muscle atrophy and weakness.

Table 4. Cardiovascular and respiratory responses during NMES for all patients (n = 50)

<table>
<thead>
<tr>
<th>Pre NMES session</th>
<th>After 20 min of NMES</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heart rate (beats per minute)</td>
<td>80 ± 13</td>
<td>80 ± 14</td>
</tr>
<tr>
<td>Systolic blood pressure (mm Hg)</td>
<td>130 ± 16</td>
<td>131 ± 15</td>
</tr>
<tr>
<td>Diastolic blood pressure (mm Hg)</td>
<td>65 ± 8</td>
<td>65 ± 10</td>
</tr>
<tr>
<td>Oxygen saturation (%)</td>
<td>97 ± 2</td>
<td>97 ± 3</td>
</tr>
<tr>
<td>Respiratory rate (beats per minute)</td>
<td>20 ± 3</td>
<td>20 ± 4</td>
</tr>
</tbody>
</table>

Table 4. Cardiovascular and respiratory responses during NMES for all patients (n = 50)

- Successful contractions obtained in 50% of patients.
- Edema, sepsis, and administration of vasopressors negatively influenced the quality of the muscle contraction induced by NMES.
- Neuromuscular blocking agents can be applied safely since none of the cardiorespiratory parameters changed significantly.
- Patients did not report negative consequences after the NMES sessions.

SUMMARY

- Results are inconclusive.
- Areas of future research:
  - Long-term effects of NMES on physical function and QOL in ICU survivors.
  - Feasibility and safety of NMES use in different subpopulations of critically ill patients.

Article # 2 and supporting evidence

- Article 1 & 2 both assessed BP, HR, HR & Q2 sats pre & post treatment of NMES intervention with no significant difference.
- Both articles supported the use of NMES to reduce muscle atrophy within the first week of stay for ICU patients: (5 days for article 1 and 7 days for article 2).

Article # 3 and supporting evidence

- Deconditioned patients obtain the best results when NMES is used in addition to standard care.
- Similar to article 1, NMES prevents skeletal muscle weakness.
- Assessment of the effectiveness of NMES for the preservation of muscle mass is inconclusive.
- Results were inconclusive after gathering data from eight eligible studies in the prevention of muscle wasting.
- No adverse effects or complications in relation to NMES safety or tolerability was reported in majority of studies in the review.

Presented by Chinwe Okoro SPT & Logan Simcox SPT