Effects of neuromuscular electrical stimulation of muscles of ambulation in patients with chronic heart failure or COPD: a systematic review of the English-language literature

CRD summary
This well-conducted review concluded that despite the limited numbers, disparity in patient populations and variability in methodology, NMES looked promising as a means of rehabilitating patients with congestive heart failure and COPD. There was sufficient evidence to warrant larger prospective randomised controlled trials. These conclusions are likely to be reliable.

Authors' objectives
To review the effects of neuromuscular electrical stimulation (NMES) of the muscles of ambulation in patients with congestive heart failure or chronic obstructive pulmonary disease (COPD).

Searching
MEDLINE, EMBASE, Cochrane Central Register of Controlled Trials (CENTRAL), CINAHL and Physiotherapy Evidence Database were searched to December 2007. Search terms were reported. Reference lists and citations were handsearched. Papers not in English and congress and conference abstracts were not considered for inclusion.

Study selection
Randomised controlled trials (RCTs) and controlled trials that reported the effects of NMES on ambulatory muscles in patients with congestive heart failure and COPD were eligible for inclusion. Comparators were sham stimulation or other placebo, usual rehabilitation care (such as ergometry cycling or treadmill walking) or usual care. Outcomes of interest were skeletal muscle function, exercise performance and disease-specific health status.

Only RCTs were included. Trials looked at NMES alone or in combination with other exercise modalities (endurance training, usual rehabilitation or active limb mobilisation) and reported a range of outcomes that included peak workload, peak oxygen uptake (VO2), muscle strength, health status and six-minute walking distance. There was substantial heterogeneity among the clinical population. Most patients in all trials were male. Patients were not always in a stable clinical condition during the trials. NMES interventions stimulated several different muscles of the lower limbs, all used biphasic impulse current forms ranging from 10Hz to 50Hz. Session times varied between 20 and 120 minutes one to two times per day for three to seven days per week. Total number of sessions ranged from 24 to 70.

The authors did not report how many reviewers performed study selection.

Assessment of study quality
Two reviewers independently assessed study validity using the published 11-item PEDro scale of internal validity and statistical reporting. Each criteria was rated as yes or no and scored to give a maximum total score of 10 points. Disagreements were resolved by consensus.

Data extraction
Data were extracted by one reviewer and checked by another using a proforma. Details of the study population, intervention and any reported outcomes were extracted.

Methods of synthesis
A narrative synthesis was adopted. This grouped studies according to patient diagnosis (congestive heart failure or COPD) and control group (sham stimulation, usual care or usual rehabilitation care) and considered the impact of methodological quality.

Results of the review
Fourteen trials were included: nine RCTs in patients with congestive heart failure (n=274) and five RCTs in patients
with COPD (n=91). COPD trials ranged from 6 to 8 points on the quality score; congestive heart failure trials ranged from 4 to 8 points. The most common methodological flaws were failure to conceal allocation and lack of blinding of patients, therapists and outcome assessors.

**NMES in congestive heart failure:**

Two trials compared NMES with usual care (n=56) but reported different primary outcomes. Across the two trials statistically significant improvements in the NMES condition were noted for peak workload and oxygen uptake, muscle strength and health status, and statistically significant decreases in fatigue.

Two trials compared NMES with sham stimulation (n=58) and both reported statistically significant improvements in health status, peak workload, oxygen uptake and six-minute walking distance.

Five trials compared NMES with endurance training (n=160) but reported only non-significant improvements for the NMES condition. The authors noted that three of these trials scored less than 6 out of 10 on the PEDro quality scale.

**NMES in COPD:**

One trial (n=15) compared NMES with usual care and reported statistically significant improvements in quadricep muscle function, exercise tolerance and health status.

Two trials (n=35) of NMES versus sham stimulation reported conflicting results. One study found no significant differences between interventions and the other reported statistically significant improvements on quadricep muscle strength and shuttle walk test. The authors noted that both trials scored 6 out of 10 on the PEDro quality scale.

One trial (n=24) compared NMES plus active limb mobilisation versus active limb mobilisation alone and found statistically significant improvements from baseline, but no significant differences between intervention groups.

One trial (n=17) compared NMES plus usual rehabilitation versus usual rehabilitation alone and found no difference in six-minute walking distance, but reported statistically significant benefits for the NMES plus rehabilitation group in quadriceps contraction and on the dyspnoea domain from a questionnaire.

Safety was not a predefined primary outcome in any of the trials; none of the studies reported any serious adverse events.

**Authors' conclusions**

Despite the limited numbers, disparity in patient populations and variability in methodology, NMES looked promising as a means of rehabilitating patients with congestive heart failure and COPD. There was sufficient evidence to warrant larger prospective randomised controlled trials.

**CRD commentary**

This review addressed a clear clinical question with appropriate inclusion criteria. Searches were sufficient, although the exclusion of unpublished and studies not in English may have introduced publication and/or language biases. The review methodology was on the whole well reported and made use of more than one reviewer to minimise potential errors; only the study selection methods were not fully described. Study quality was assessed using a validated tool and the results were presented clearly. A narrative synthesis seemed appropriate given clear clinical heterogeneity. Study quality was explicitly incorporated in the synthesis.

The authors' cautious conclusions appeared to reflect the evidence presented and take into account the small trials of variable quality. Overall the findings of this review can be considered reliable.

**Implications of the review for practice and research**

**Practice:** The authors did not state any implications for practice.
Research: The authors stated that further prospective high-quality blinded randomised trials were warranted to clarify how NMES could be utilised optimally. Such trials should consider a duration of at least six weeks, use detailed inclusion criteria for patients and optimal NMES protocols including reporting changes in NMES pulse intensity over time.

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