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HD-tDCS for Weaning from Mechanical Ventilation in Acute Respiratory Failure, Double Blind, Randomized Controlled Trial

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Objective

❖ This study investigated whether HD-tDCS combined with conventional ICU rehabilitation improves ventilator-free days (VFDs) and functional outcomes in patients with acute respiratory failure requiring MV.

Methods

❖ **Design**

- Single-center, double-blinded, randomized controlled trial
- ICU at Chungnam National University Sejong Hospital between March 2023 and December 2024

❖ **Selection criteria**

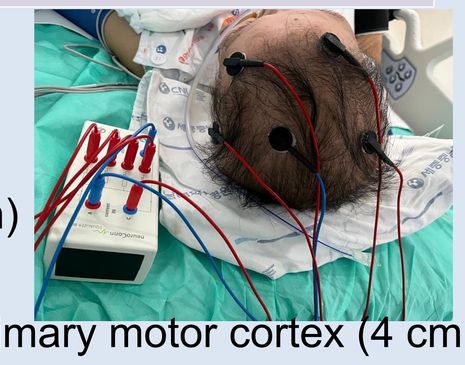
Inclusion criteria

1. Age ≥ 19 years
2. Diagnosed with acute respiratory failure by a specialist
3. Requiring MV ≥24 hours

Exclusion criteria

1. Pregnant women
2. Neuropathy or myopathy
3. Brain death
4. Severe traumatic brain injury, brain tumor, or other brain lesions affecting respiration or ventilation
5. History of epilepsy or seizures
6. Intracranial metallic implants; cardiac implantable electronic devices or temporary pacing devices
7. Cognitive impairment
8. Diaphragmatic trauma or hernias
9. Multiple trauma or severe burns
10. Prior thoracotomy or cardiothoracic surgery;
11. Life expectancy of less than 12 months;
12. Chronic respiratory failure requiring home ventilator support;
13. Current extracorporeal membrane oxygenation

❖ **Intervention**



- **Schedule**
  - 10 weekdays intervention
  - 2 sessions/day (morning & afternoon)
- **Electrode montage**
  - Center anode: Left diaphragmatic primary motor cortex (4 cm lateral, 1 cm anterior to bianaural line)
  - 4 cathodes: Placed equidistantly7.5 cm from center anode
- **Active stimulation protocol**
  - Ramp-up: 10 sec; Stimulation: 2 mA for 30 min; Ramp-down: 10 sec (total 30 min)
- **Sham stimulation**
  - Ramp-up: 8 sec; Brief stimulation: 30 sec; Ramp-down: 5 sec
  - No stimulation for remaining time (total 30 min)
- All participants received rehabilitation therapy according to a standardized ICU rehabilitation

❖ Assessment time points: Baseline → Day 5 → Day 10

❖ Assessments: RASS, MRC sum score, Grip strength, FSS-ICU, MIP, Diaphragm excursion, Diaphragm thickness fraction

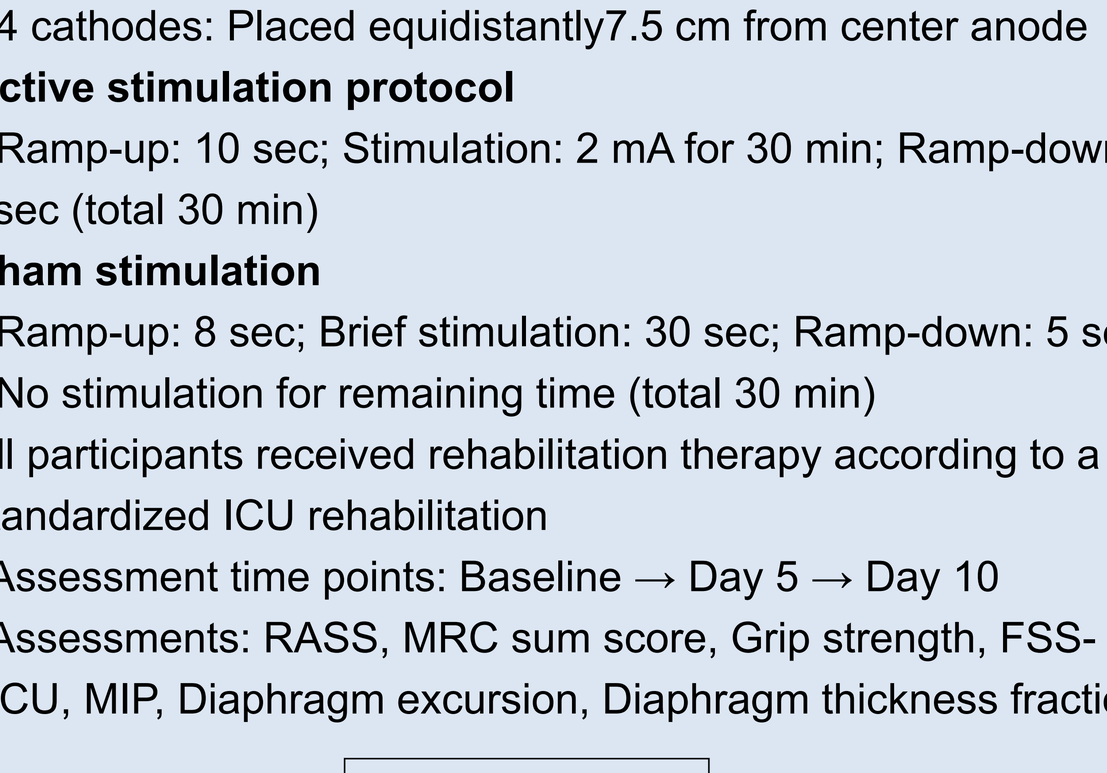


Figure 2. CONSORT flow chart

Results

Table 1. Demographics and baseline clinical characteristics

Variables	Sham group (n=17)	Active group (n=14)	p-value
Age (mean±SD)	71.00±15.67	65.64±14.68	0.338
Sex (male, %)	69.70 (94.1%)	68.37 (71.4%)	0.148
Height (cm, mean±SD)	165.24±7.20	165.41±7.82	0.948
Weight (kg, mean±SD)	64.72±16.42	63.33±15.32	0.811
BMI (kg/m^2, mean±SD)	23.58±4.99	23.02±4.85	0.754
CCI (mean±SD)	5.65±2.83	4.93±2.73	0.480
Baseline clinical parameters (mean±SD)			
RASS	-2.00±1.66	-1.86±1.29	0.794
MRC sum score	35.09±11.22	35.20±10.25	0.982
FSS-ICU	3.06±6.23	3.36±4.81	0.884
SOFA	11.88±4.00	10.36±3.10	0.253

❖ **Primary outcome**

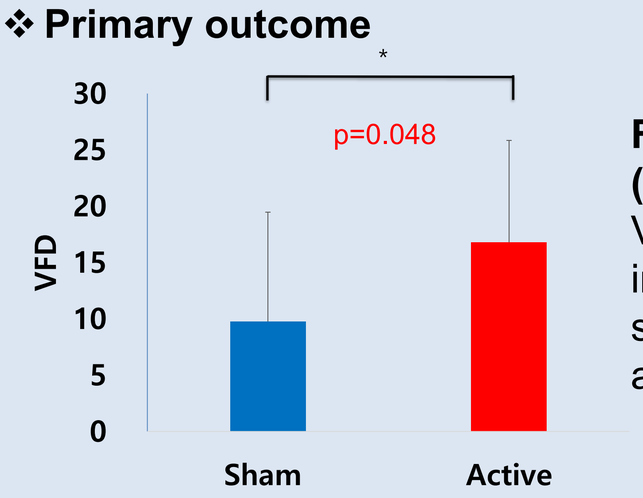


Figure 3. Ventilator-free days (VFDs).
VFDs were significantly higher in the active group than in the sham group ($p < 0.05$). Data are presented as mean ± SD.

❖ **Secondary outcome**

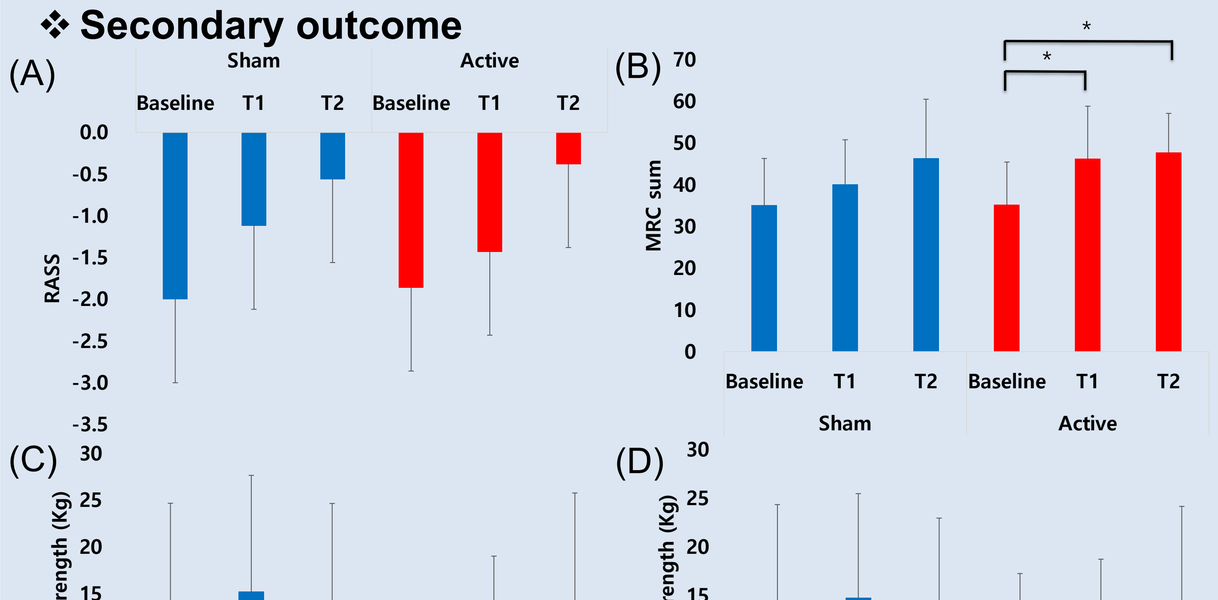


Figure 4. Neurologic and functional outcomes. (A) RASS, (B) MRC sum, (C) Rt. Grip strength, (D) Lt. Grip strength, (E) FSS-ICU, (F) MIP

Conclusions

❖ **HD-tDCS combined with ICU rehabilitation was associated with increased ventilator-free days and improved inspiratory muscle strength in mechanically ventilated critically ill patients. HD-tDCS may represent a promising adjunctive therapy to facilitate respiratory recovery in the ICU.**

This work was supported by a National Research Foundation of Korea (NRF) grant funded by the Korean government (MSIT) (NRF-2022R1A2C1092776).