# EXERCISE ENDURANCE AND FUNCTIONAL MOBILITY IMPROVE FOR INDIVIDUALS WITH PHYSICAL DISABILITIES AFTER TRAINING ON A MOTORIZED ELLIPTICAL

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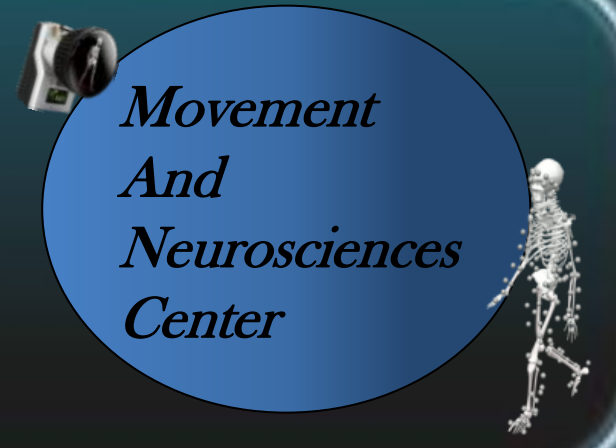
Introduction

ICARE, an Intelligently Controlled Assistive Rehabilitation Elliptical, was designed for use across healthcare settings to improve cardiovascular (CV) fitness and walking of individuals with physical disabilities.[1] The system integrates an intelligently controlled motor providing assistance for continuous pedal motion at speeds up to 65+ revolutions per minute (rpm), enabling individuals with weakness and/or decreased endurance to utilize the device.[2] Additional adaptations include safety rails, steps, a ramp, an adjustable height seat, a body weight support (BWS) system, and footplate straps for improved accessibility and usability. Overall, the modifications incorporated into ICARE minimize the need for assistance and improve feelings of safety and comfort for an enhanced exercise experience by individuals with various medical conditions.[3]

Purpose

This study's primary objective was to assess use of ICARE as an adjunct to physical therapy (PT) in individuals with physical disabilities and/or chronic conditions. We hypothesized that ICARE could serve as a feasible therapeutic treatment to improve CV fitness and functional mobility.

Participants

Ten individuals receiving outpatient PT participated (mean height: 1.69 m ± 0.13; mean mass: 94 kg ± 19).

Table 1. Participant Characteristics and Diagnoses

Subject	Gender	Age (y)	Primary Diagnosis
1	Female	46	Multiple Sclerosis
2	Male	67	Parkinson's Disease
3	Female	48	Multiple Sclerosis
4	Male	58	Encephalitis
5	Male	55	Spinal Cord Injury
6	Male	29	Guillain Barré
7	Female	54	Stroke
8	Female	68	Spinal Cord Injury
9	Female	88	Blood Infection
10	Female	42	Stiff Person Syndrome

Methods

Figure 1. Individual training on ICARE

Instrumentation
- ICARE Trainer: Base model (SportsArt E870)

Procedures
- Participants ICARE trained for 12 sessions
- Prior to and after training, balance and walking assessments performed
- Training progression determined by physiologic and fatigue responses

Data Analysis
- Duration, strides, velocity, stride length, BWS, perceived exertion (RPE), heart rate, and blood pressure (BP) recorded during each session
- Comfortable walking velocity (CWS), fast walking velocity (FWS), 5 Minute Walk Test (5MWT), Timed Up and Go (TUG), and Berg Balance Test (BBS) assessed pre and post training

Statistical Analysis
Paired t-tests (significance set at $p<0.05$) evaluated changes across training parameters, physiological measures, and clinical assessments.

Results

Table 2: Differences in ICARE training parameters between second & last session (mean, SD)

Parameter	Second Session	Last Session	Significance
Session Duration (s)	586 (265)	899 (272)	p=0.001
Strides/Session	330 (214)	621 (319)	p<0.001
Velocity (rpm)	33.8 (6.9)	40.7 (8.8)	p=0.003
Stride Length (m)	22 (4)	26 (3)	p=0.030
BWS (% BW)	14 (10)	10 (11)	Not significant

Table 3: Comparison of physiological measures between second & last session (mean, SD)

Measure	Second Session	Last Session	Significance
RPE	12 (2)	13 (2)	Not significant
Heart Rate	95 (17)	98 (19)	Not significant
Systolic BP	133 (24)	129 (22)	Not significant
Diastolic BP	79 (12)	76 (11)	Not significant

Table 4: Changes in functional measures between pre and post training (mean, SD)

Measure	Pre Training	Post Training	Significance
CWS (m/s)	0.50 (.35)	0.61 (.43)	Not significant
FWS (m/s)	0.67 (.44)	0.73 (.46)	Not significant
5MWT (m)	106 (67)	137 (87)	p=0.002
TUG (s)	33.2 (24.0)	31.2 (26.6)	Not significant
BBS	37(15)	40 (15)	p=0.004

Discussion

Changes in ICARE training parameters over the program's course suggest that exercise tolerance improved, with individuals enduring longer exercise bouts at higher speeds without an increase in perceived exertion, HR, or BP. Functional mobility improvements (balance and walking endurance) were documented. No adverse events were reported, suggesting that ICARE training is a feasible treatment option for individuals with a wide variety of diagnoses receiving outpatient therapy.

Conclusion

ICARE is a practical training device likely to benefit individuals with limited functional abilities receiving PT. Given that ICARE training was provided as an adjunct to therapy, the intervention's independent effects cannot yet be determined. Work is currently underway to assess ICARE utilization for individuals with chronic conditions not concurrently enrolled in PT. Future ICARE investigations need to consider the most effective combination of training parameters (e.g., training speed, level of BWS, stride length, duration of exercise sessions) and evaluate in what phases of disease process or injury recovery individuals are most responsive.

References

1. Burnfield et al (2011). *Physical Therapy,* 91(11):1604-1617.
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3. Burnfield et al (2010). *Physical Therapy,* 90(2):289-305.

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