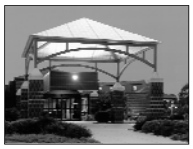
American Medical Rehabilitation Providers Association

ICARE: An Affordable Technology to Promote Walking and Cardiovascular Fitness during Rehabilitation and Following Discharge



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Objectives

- Highlight key findings from research aimed at breaking down barriers to physical activity for individuals with physical disabilities
- Describe development of ICARE, an Intelligently Controlled Assistive Rehabilitation Elliptical training system
- Discuss ICARE applications in rehabilitation and community settings

- 54 million in United States living with chronic condition or disability
- At increased risk for developing additional medical problems

(US Census Bureau Report P70-73, 2001; US Census Bureau Brief C2KBR-17; National Center for Health Statistics, 2006; Thurman et al, 1999)

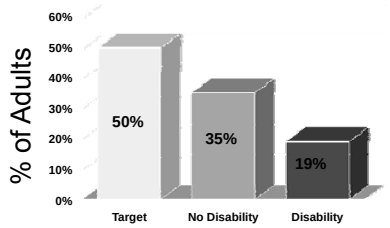
Exercise

- Prevent or delay onset of other medical diseases
- Decrease disease severity
- Reduce functional declines associated with inactivity

Healthy People 2020

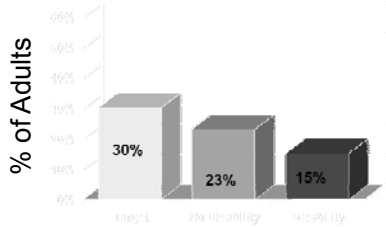
10-year nationwide agenda aimed at improving the health of all people in the United States

Moderate, Regular Physical Activity (≥30 minutes, 5 times/week)



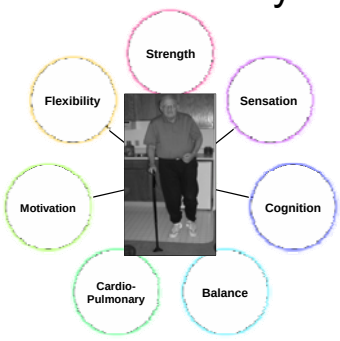
DATA2010...the Healthy People 2010 Database - Objective: 22-02
Accessed September 29, 2010: http://wonder.cdc.gov/data2010/obj.htm

Muscular Strength and Endurance Activities



DATA2010...the Healthy People 2010 Database - Objective: 22-04
Accessed September 29, 2010: http://wonder.cdc.gov/data2010/obj.htm

Barriers to Physical Activity

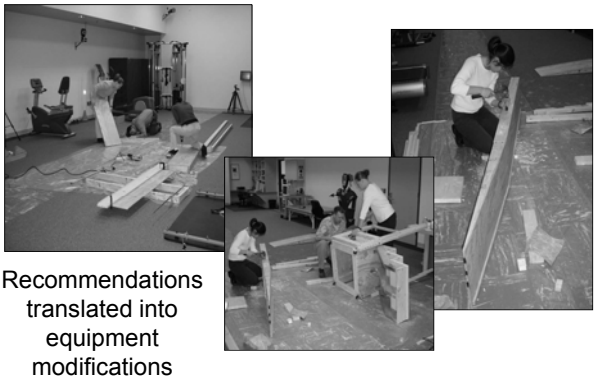


Individual

Societal

Rimmer et al, *American Journal of Preventive Medicine,* 2004

Research funded, in part, by the Daniels Fund



Recommendations translated into equipment modifications

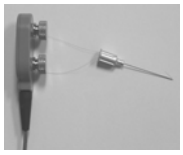
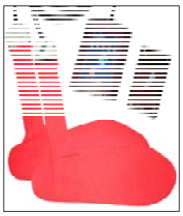
Research funded, in part, by the Daniels Fund

Biomechanical Comparisons

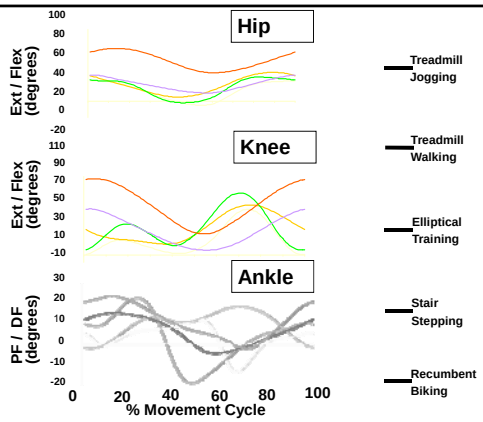




Biomechanical Assessments

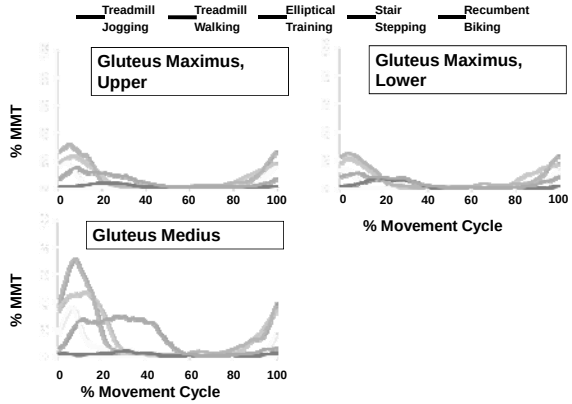





KINEMATICS (JOINT MOTION)

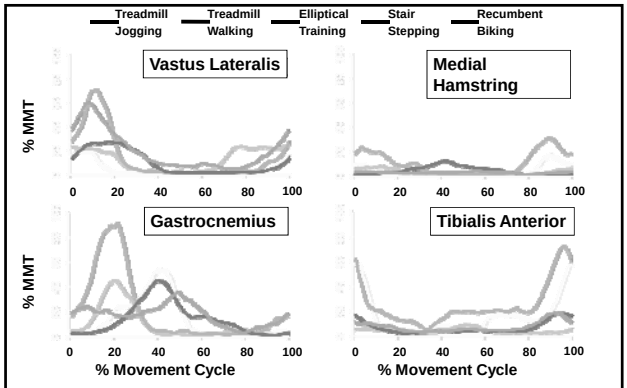


Buster TW, Taylor AP, Frazier M, Burnfield JM. Kinematic analysis of five cardiovascular exercises. *Online Proceedings, American Society of Biomechanics 34th Annual Meeting,* pgs. 324-325.

ELECTROMYOGRAPHY (MUSCLE ACTIVATION)

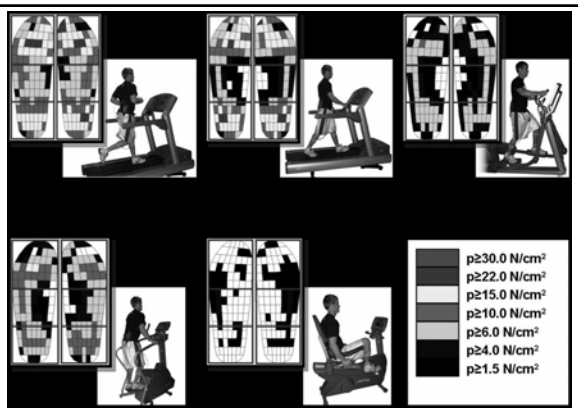


Takahashi S, Burnfield JM, Buster TW, Provorse AR (2007). Comparison of Gluteal Muscle Electromyographic Activity across Five Cardiovascular Exercises in Healthy Young Adults. *Medicine and Science in Sports and Exercise,* Volume 39(5), pg. S255.



- Burnfield JM, Roemmich RT, Scherr T, Buster TW (2009). Comparison of Vastus Lateralis and Medial Hamstring EMG Activity Across Five Cardiovascular Exercises. *MSSE*, 41(5), pgs. S568-569.
- Buster TW, Roemmich RT, Doher NJ, Burnfield JM (2009). Comparison of Ankle Muscle EMG Activity Across Five Cardiovascular Exercises. *MSSE*, 41(5), pg. S569.

PLANTAR PRESSURES



Burnfield JM, Jorde AG, Augustin TR, Augustin TA, Bashford GR (2007). Variations in plantar pressure variables across five cardiovascular exercises. *Medicine and Science in Sports and Exercise,* 39(11):2012-2020.

Elliptical Training

Development of an Intelligently Controlled Assistive Rehabilitation Elliptical (ICARE) Training System to Promote Walking and Fitness in Persons with Physical Limitations

Research funded by the National Institute on Disability and Rehabilitation Research

NIDRR Grant # H133G070209

Principal Investigator: Burnfield

Co-Investigators: Nelson (UNL); Goulet (Creighton)

ICARE Goal

Develop inexpensive tool that could be used to help people with physical disabilities regain walking capacity and physical fitness

- Inpatient setting
- Outpatient setting
- Fitness facilities
- Homes

ICARE Conceptual Framework

- **Task Specificity:** If you want to work on walking, then task needs to mimic walking
- **Mass Repetition:** Neuroplasticity of brain requires not just 10-20 steps, but 100s to 1000s

Richards et al 1993; Kwakkel et al, 1999; Carr and Shepherd, 1998; Nudo, 1997.

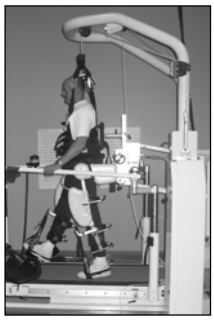
Partial Body Weight Support Treadmill Training

- Improves walking function
- Unfortunately, labor intensive and equipment not readily accessible

Kosak and Reding, 2000; Werner et al, 2002

- Buster TW, Goldman AJ, Corbridge LM, Shu Y, Burnfield JM (2009). Partial Body Weight Support Treadmill Training: Clinician's Upper Extremity Muscle Activation During Facilitation of Hemiparetic Limb Movement. *Proceedings, Gait and Clinical Movement Analysis Society 14th Annual Meeting, pgs 258-259.*
- Corbridge LM, Goldman AJ, Shu Y, Buster TW, Burnfield JM (2009). Clinician's Muscle Effort During Partial Body Weight Support Treadmill Training: Is it Hard Work? *Online Proceedings, American Physical Therapy Association's 2009 Annual Conference and Exposition (http://www.apta.org/AM/abstracts/pt2009/abstractsPt.cfm?m_id=19675).*

Robotic Devices

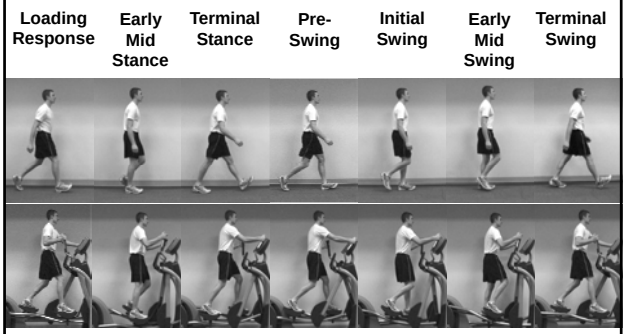


Lokomat

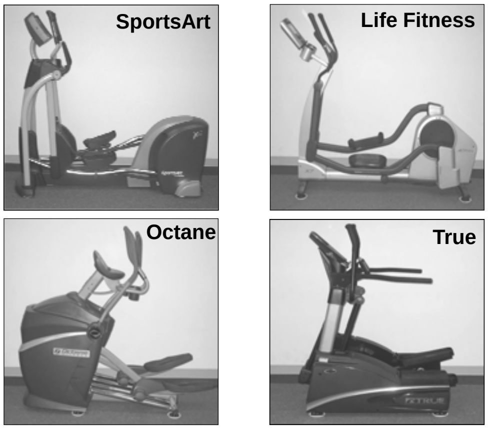
REO Ambulator

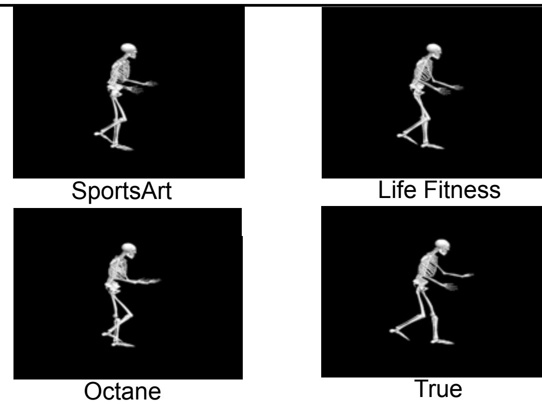
Colombo et al, 2000; Werner et al, 2002

Notable Similarities to Gait



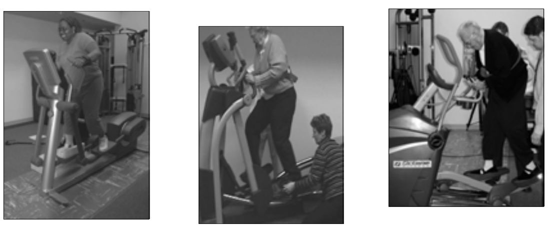
Burnfield JM, Shu Y, Buster TW, Taylor A (2010). Similarity of joint kinematics and muscle demands between elliptical training and walking: Implications for practice. *Physical Therapy,* 90(2): 289-305.





Burnfield JM, Shu Y, Buster TW, Taylor A (2010). Similarity of joint kinematics and muscle demands between elliptical training and walking: Implications for practice. *Physical Therapy*, 90(2): 289-305.

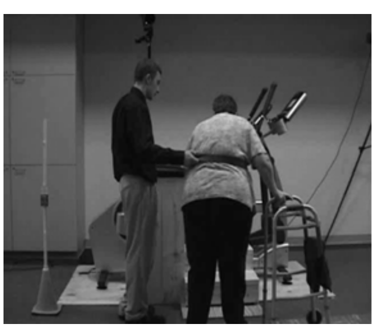
ICARE – Ergonomic and Engineering Redesign



- Burnfield JM, Buster TW, Taylor A, Keenan S, Shu Y, Nelson CA (2010). Intelligently Controlled Assistive Rehabilitation Elliptical (ICARE) Training: An Analysis of Lower Extremity Electromyographic (EMG) Demands with Varying Levels of Motor Assistance. *Online Proceedings, Rehabilitation Engineering and Assistive Technology Society of North America's 2010 Annual Conference.*
- Shu Y, Buster TW, Taylor A, Keenan S, Nelson CA, Burnfield JM (2010). Ergonomic redesign of elliptical trainer to promote greater safety, comfort and usability. *Online Proceedings, Rehabilitation Engineering and Assistive Technology Society of North America's 2010 Annual.*

ICARE – Ergonomic Assessments

Shu Y, Buster TW, Taylor A, Keenan S, Nelson CA, Burnfield JM (2010). Ergonomic redesign of elliptical trainer to promote greater safety, comfort and usability. *Online Proceedings, Rehabilitation Engineering and Assistive Technology Society of North America's 2010 Annual.*



Shu Y, Buster TW, Taylor A, Keenan S, Nelson CA, Burnfield JM (2010). Ergonomic redesign of elliptical trainer to promote greater safety, comfort and usability. *Online Proceedings, Rehabilitation Engineering and Assistive Technology Society of North America's 2010 Annual.*

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ICARE-1 Prototype

Developed under a grant from the Department of Education
NIDRR grant number H133G070209

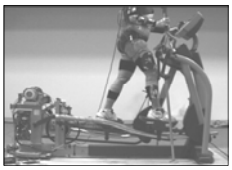
Intelligent Motor Control System

- Generates sufficient torque to move pedals at constant speed while clients use ICARE
- Training speed ranges from ~25 to 65 RPM
- Enables individuals with lower extremity muscle weakness and/or reduced endurance to train

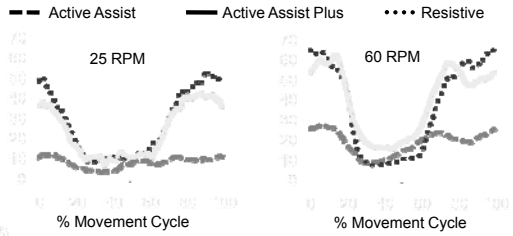
Burnfield JM, Buster TW, Taylor A, Keenan S, Shu Y, Nelson CA (2010). Intelligently Controlled Assistive Rehabilitation Elliptical (ICARE) Training: An Analysis of Lower Extremity Electromyographic (EMG) Demands with Varying Levels of Motor Assistance. *Online Proceedings, Rehabilitation Engineering and Assistive Technology Society of North America's 2010 Annual Conference.*

3 Motor Conditions

- **Active Assist**: motor assists leg movements
- **Active Assist Plus**: motor disengages when participant's speed exceeds threshold speed
- **Resistive**: motor remains disengaged (provides no physical assistance)



ICARE Vastus Lateralis Muscle Demand



ICARE-1 Prototype

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Clinical Test Environments

- Inpatient
- Outpatient
- Fitness Facility

Patent Pending

Development of an Intelligently Controlled Assistive Rehabilitation Elliptical (ICARE) Training System to Promote Walking and Fitness in Persons with Physical Limitations

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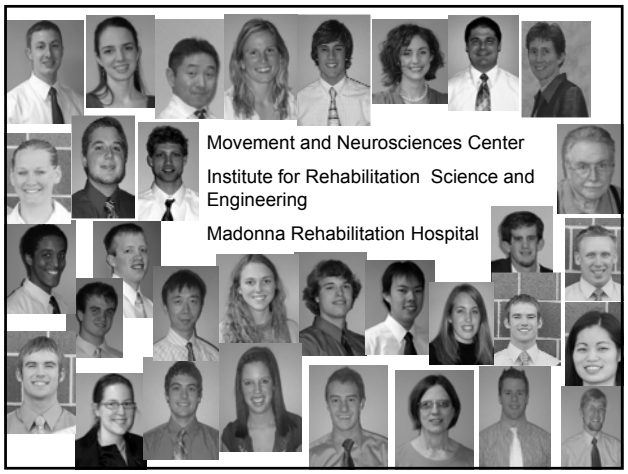

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