

Training im All und auf der Erde: Chancen und Herausforderungen im digitalen Zeitalter

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Knowledge for Tomorrow



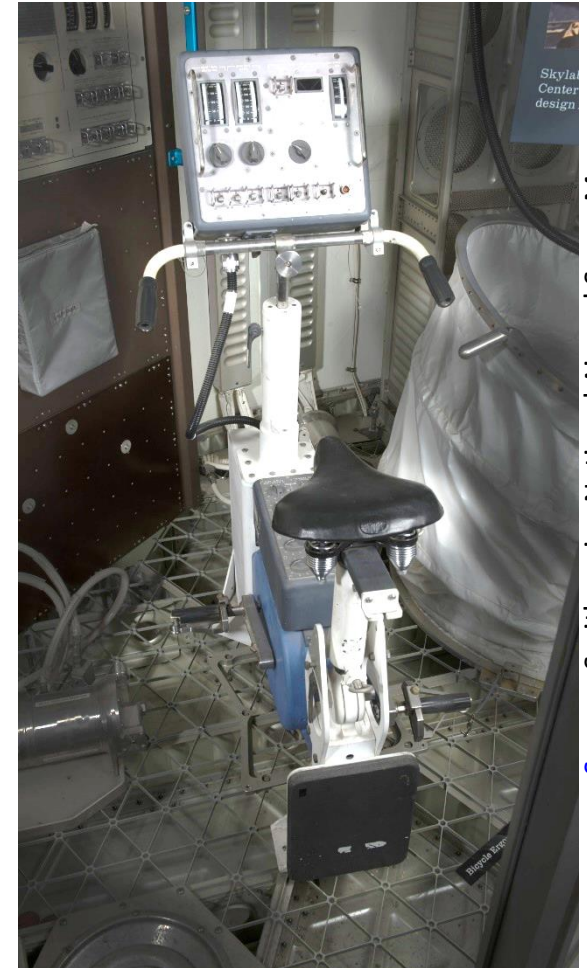
Jörn Rittweger



- Der Referent: Jörn Rittweger ist Professor für Weltraumphysiologie an der Universität zu Köln und gleichzeitig Leiter der Abteilung für Muskel- und Knochenstoffwechsel am DLR-Institut für Luft- und Raumfahrtmedizin. Er befasst sich mit dem Bewegungsapparat des Menschen in der Raumfahrt, in der Klinik und im Alter. Außerdem engagiert er sich im ‚Kompetenznetzwerk immobilisationsbedingte Muskelstörungen‘, in dem u.a. die Lehren aus der Raumfahrt für die Erde nutzbar gemacht werden.
- Der Vortrag: Regelmäßiges Training ist geeignet, die körperliche und geistige Leistungsfähigkeit zu stärken und die Gesundheit zu erhalten. Dies gilt auch und vor allem in Extremsituationen wie z.B. in der Schwerelosigkeit, oder in der Rehabilitation nach einem Unfall. Regelmäßig wiederkehrende Probleme hierbei sind die Dosierung und Individualisierung des Trainings, sowie die Motivation der Patienten und die Unterstützung der Therapeuten. Der Vortrag zeigt deshalb neben den Randbedingungen für Trainings-Interventionen die Chancen, welche durch digitale Unterstützung entstehen können.



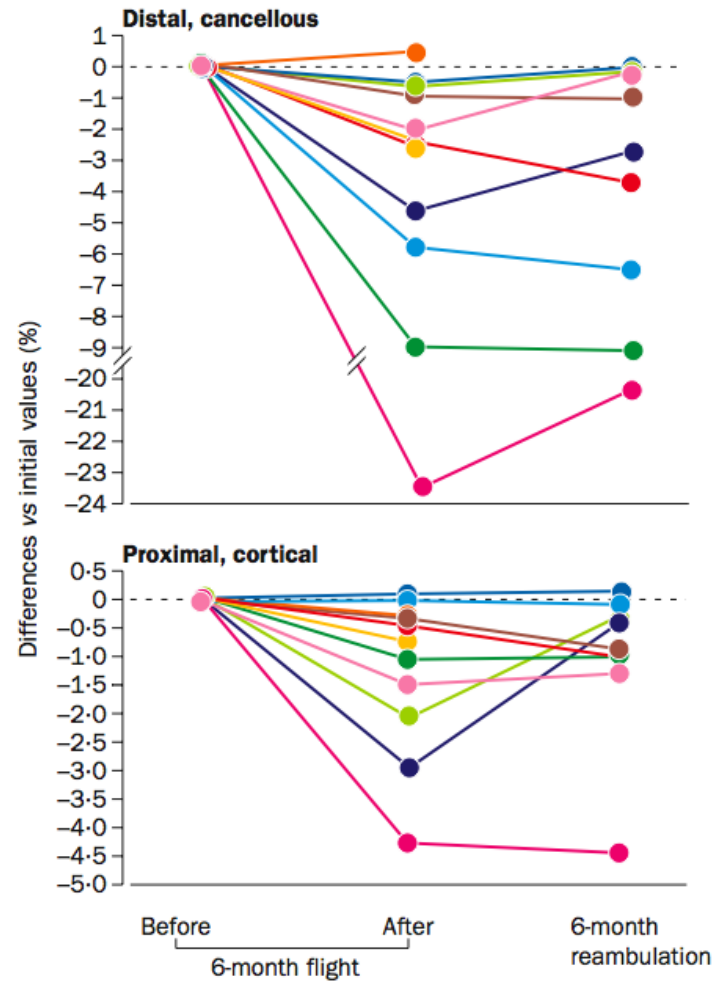
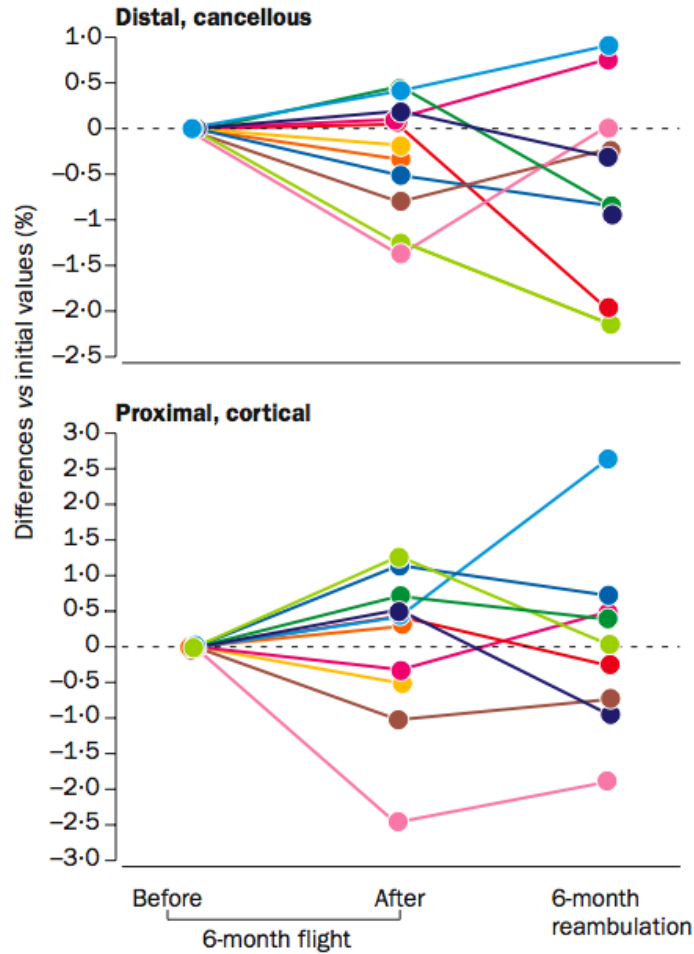
Skylab Mission (1973): Designing a bicycle-saddle for microgravity



Source: Smithsonian National Air and Space Museum



Bone Loss in Space



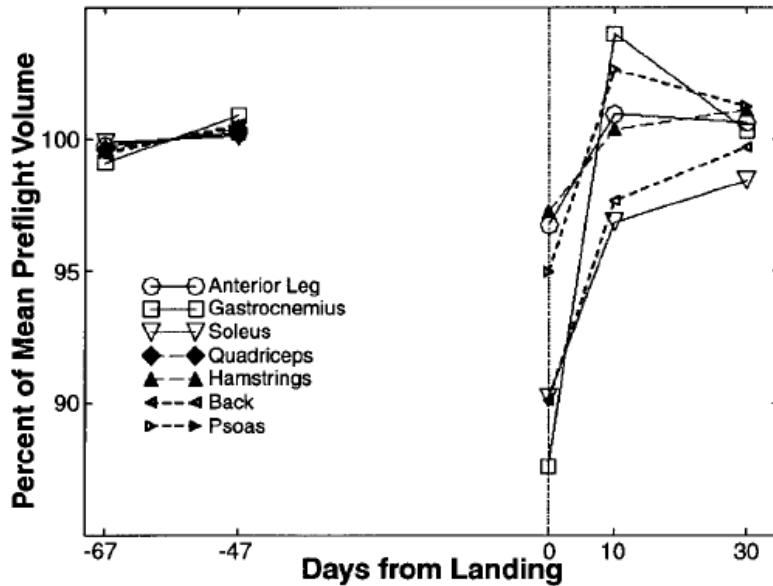
Vico et al, Lancet 355:1607-1611 (2000)



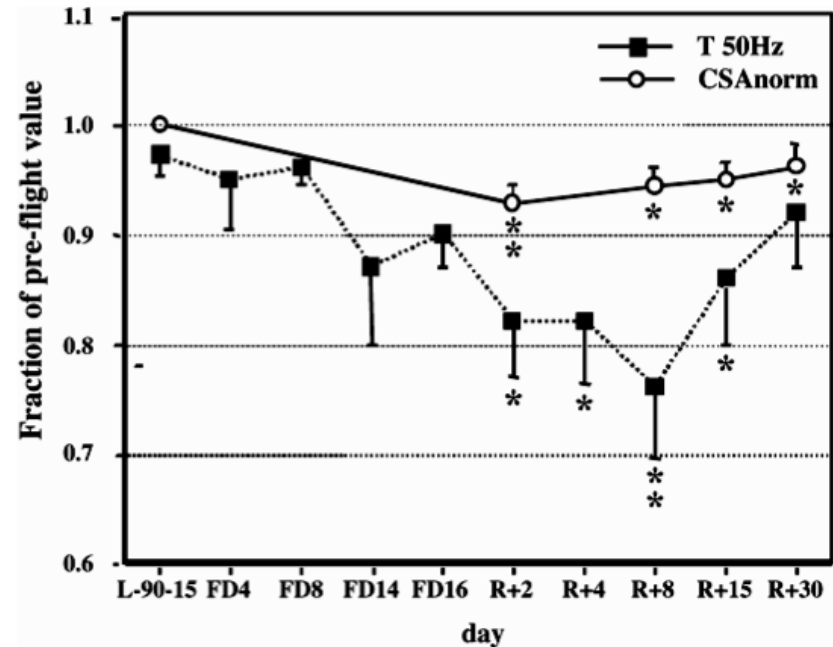
Muscle Wasting in Space



Muscle Volume



Specific Force



LeBlanc, Shenkman, Kozlovskaya et al, *J Appl Physiol* 89:2158-2164 (2000)

Narici, Kayser, Barattini, Ceretelli, *Eur J Appl Physiol* 90:275-282 (2003)

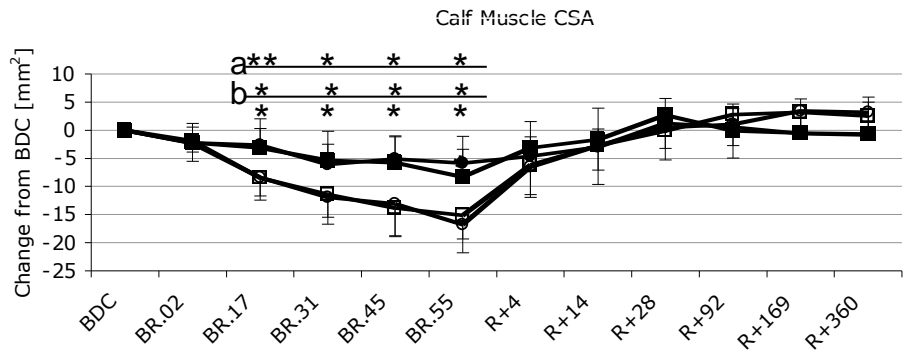
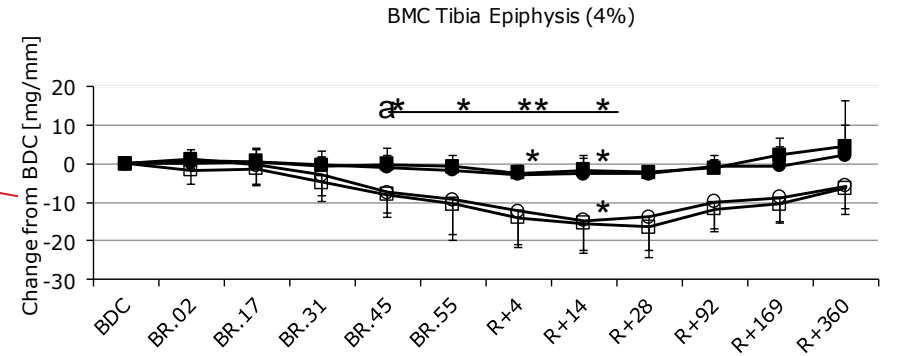
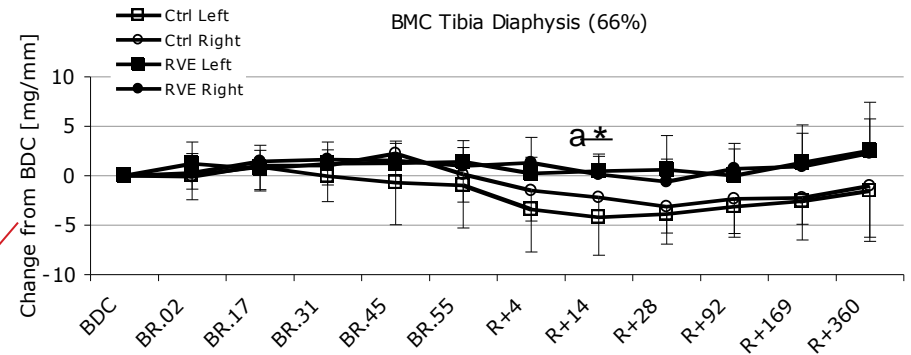


Resistive Vibration Exercise Rescues Muscle & Bone in Bed Rest

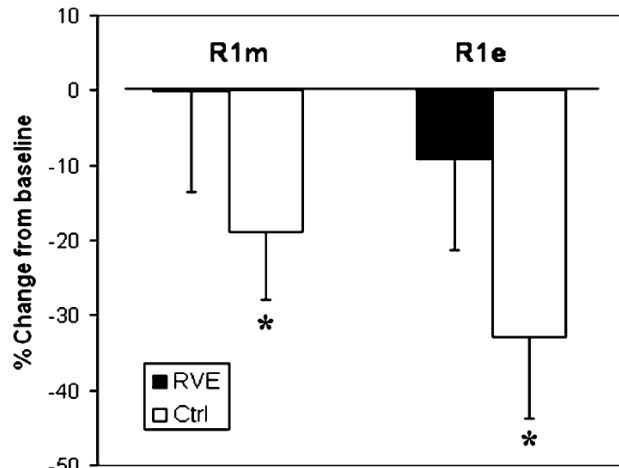
(Berlin 2002/3)



Isometric Plantar Flexion Torque



Ritweger et al., Bone 44(2):214-224 (2009)



Blottnér et al, Eur J Appl Physiol 97(3), 261-271 (2006)



Space Medicine Facilitates Clinical Applications on Earth

Vibration training during experimental bed-rest



Vibration training in pediatric rehabilitation



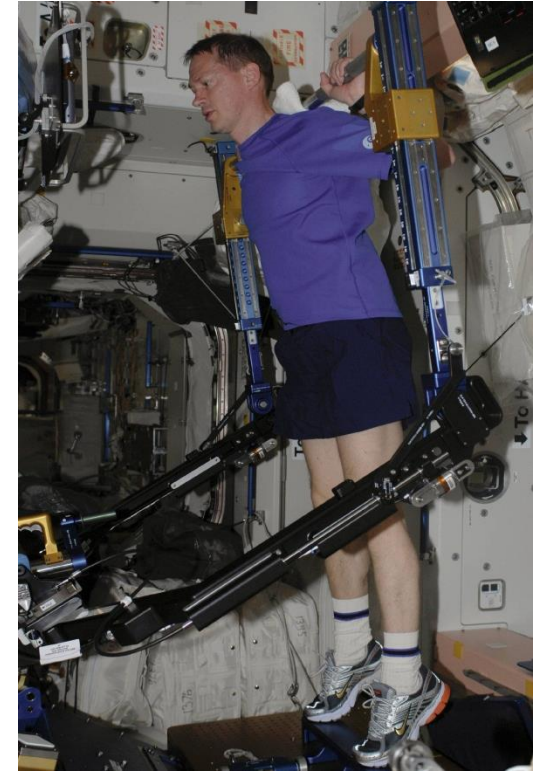
Countermeasure exercises on board the ISS



T2 (Colbert)



CEVIS



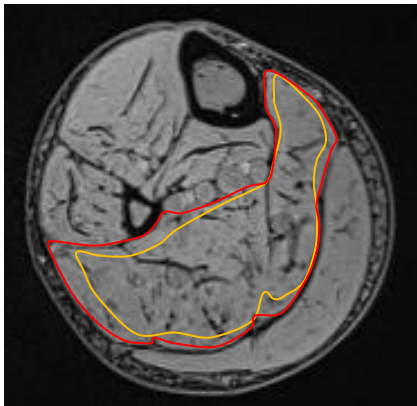
ARED



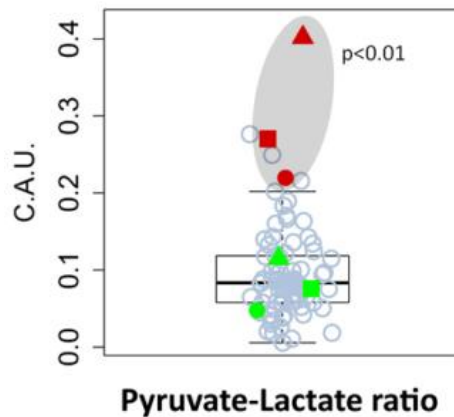
Combating muscle wasting in Space

- Microgravity, aging, chronic disease: Muscle wasting
- Despite 2hrs of exercise astronauts still lose leg muscle mass (15%, comparable to 30 years of age-related muscle wasting)
- Muscle wasting causes metabolic disrupture and general inflammation
- Exercise reduces muscle wasting, but not metabolic changes

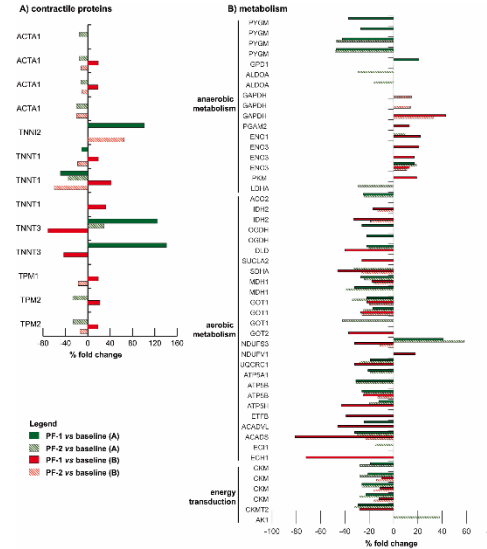
Magnetic Resonance Imaging



Blood or Urine Samples



Muscle Proteomics



On-going Study Sarcolab-3



Rittweger et al. (2018)

ESA astronaut using MARES on ISS





Bed Rest in Older People



Disability Measures

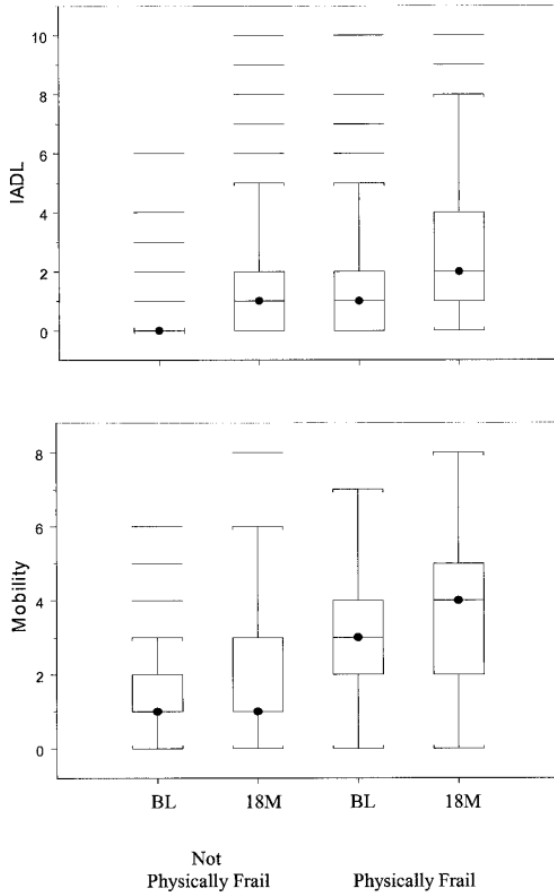


Table 2. Exposure to Bed Rest During 18-Month Follow-Up Period

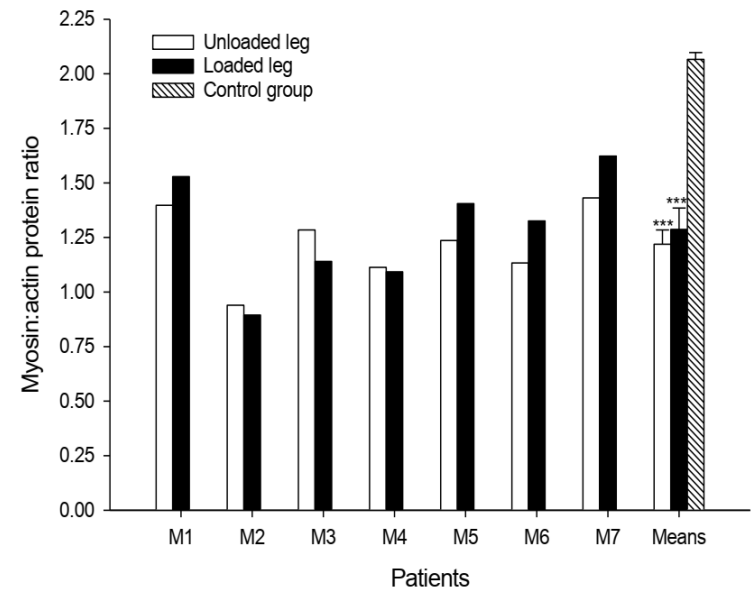
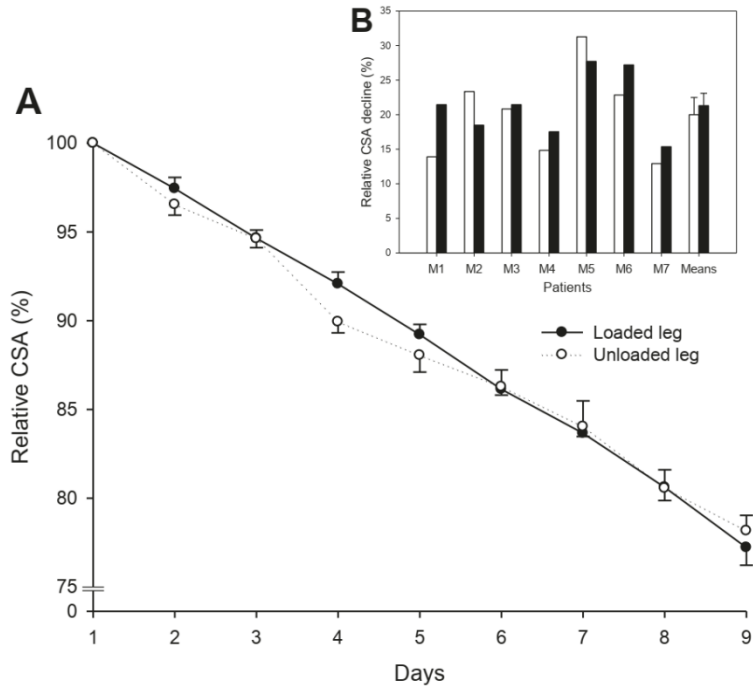
Number of Months With Bed Rest*	Overall (N = 680)	Physically Frail	
		No (N = 402)	Yes (N = 278)
		<i>Percentage of Participants[†]</i>	
None	40.6	46.0	32.7
One	23.2	21.6	25.5
Two to three	21.2	21.9	20.1
Four or more	15.0	10.4	21.6

- Community-living older people spend every 6th day in bed because of health problems
- Bed-riddenness is strongly associated with deterioration of mobility

TM Gill et al., J Gerontol A Biol Sci Med Sci 59(7):755-761 (2004)



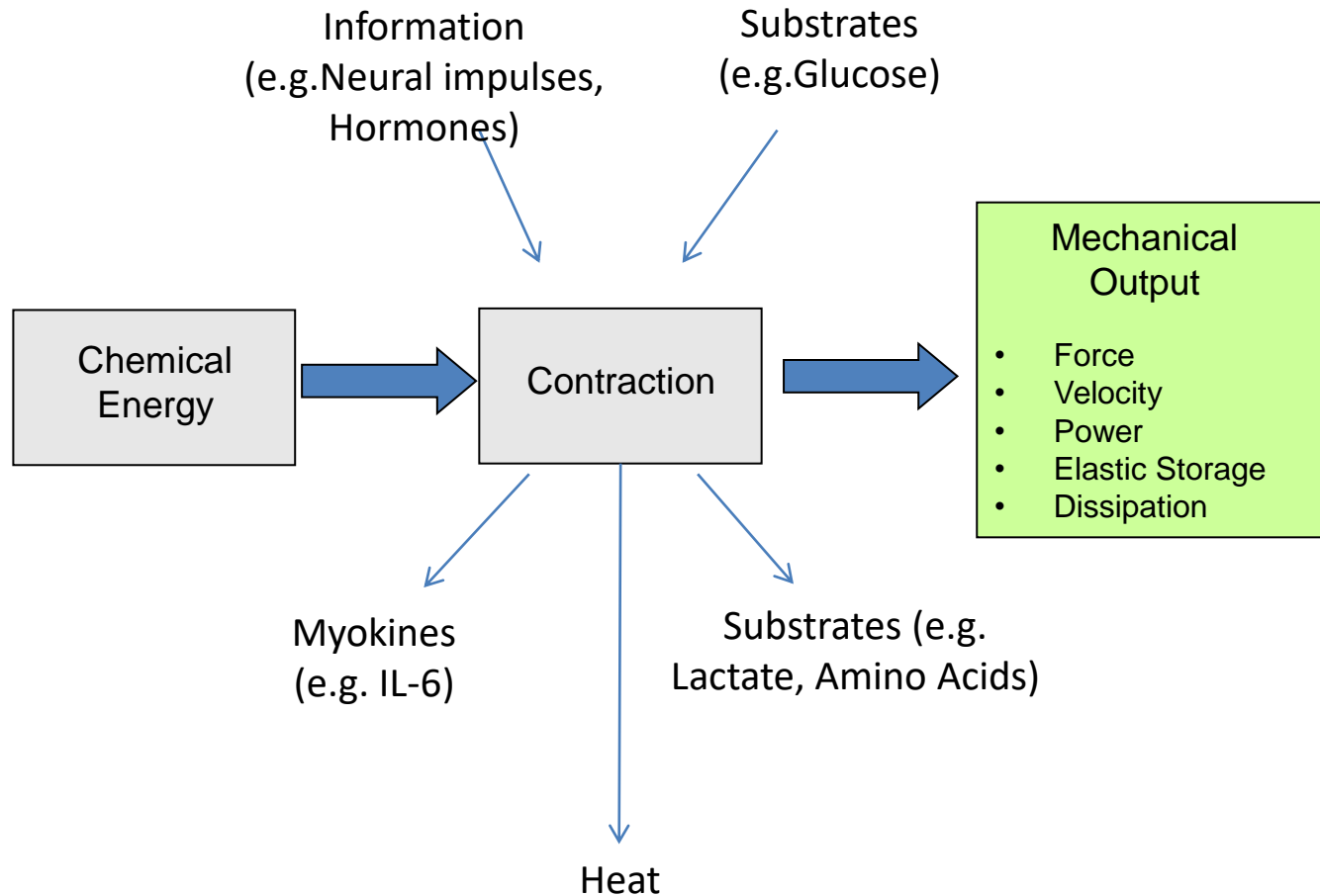
Critical Illness Myopathy: An Exaggerated Mode of Muscle Wasting



Llano-Diez et al, Crit Care 16(5): R209. (2012)



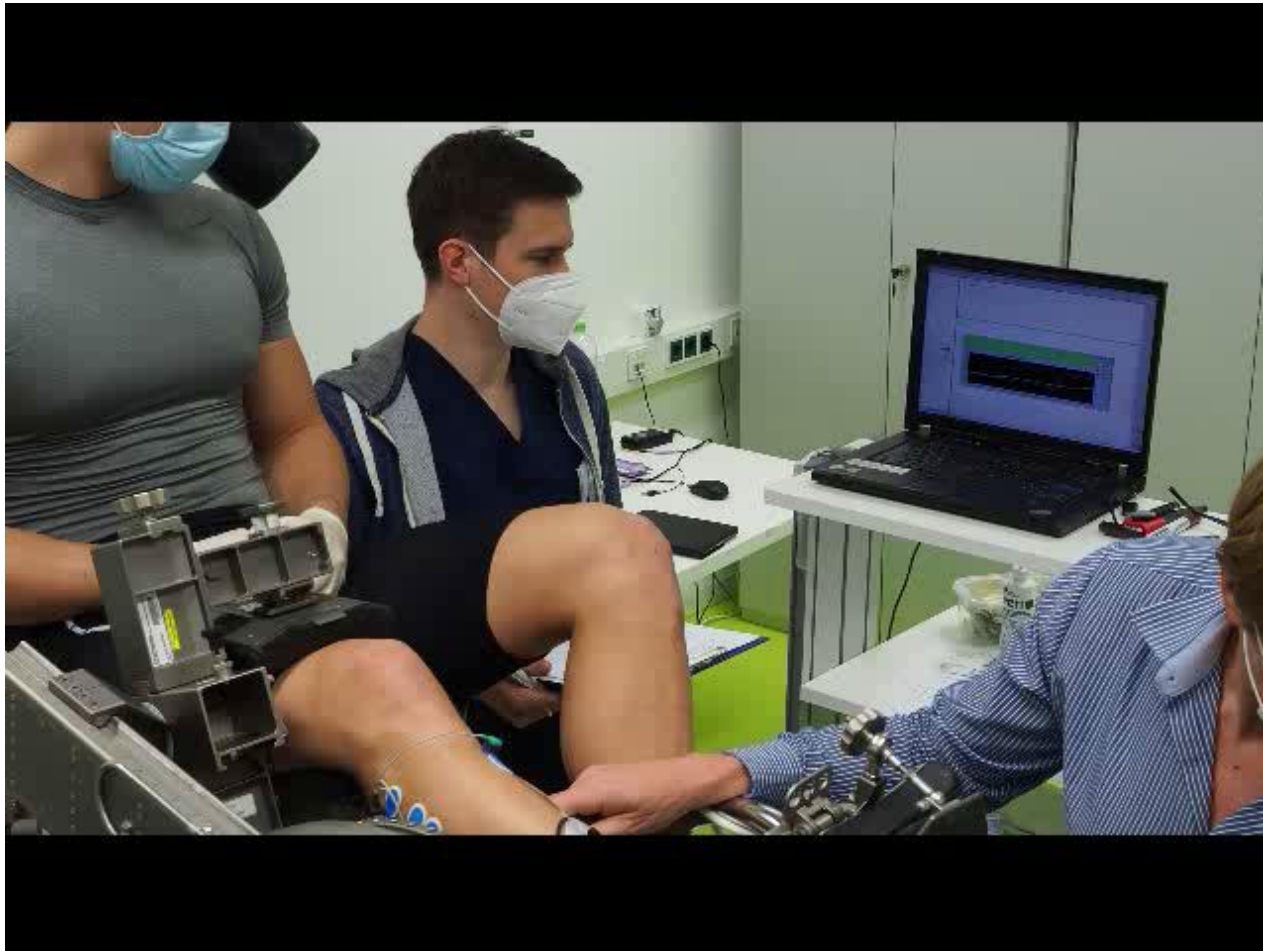
Muscle has eight different functions



Rittweger, Submitted (2020)



User Interaction with MARES



Points for Discussion

- Our understanding of how relevant muscle is for our health is still evolving
- Good exercises for muscle are badly needed in Space and on Earth
- Feasibility, economic viability, and user adherence are the biggest challenges
- Inter-disciplinary approaches are mandatory
- Accordingly, traditional bottom-up or top-down strategies are bound to fail





Ceterum censeo Lunam esse explorandam