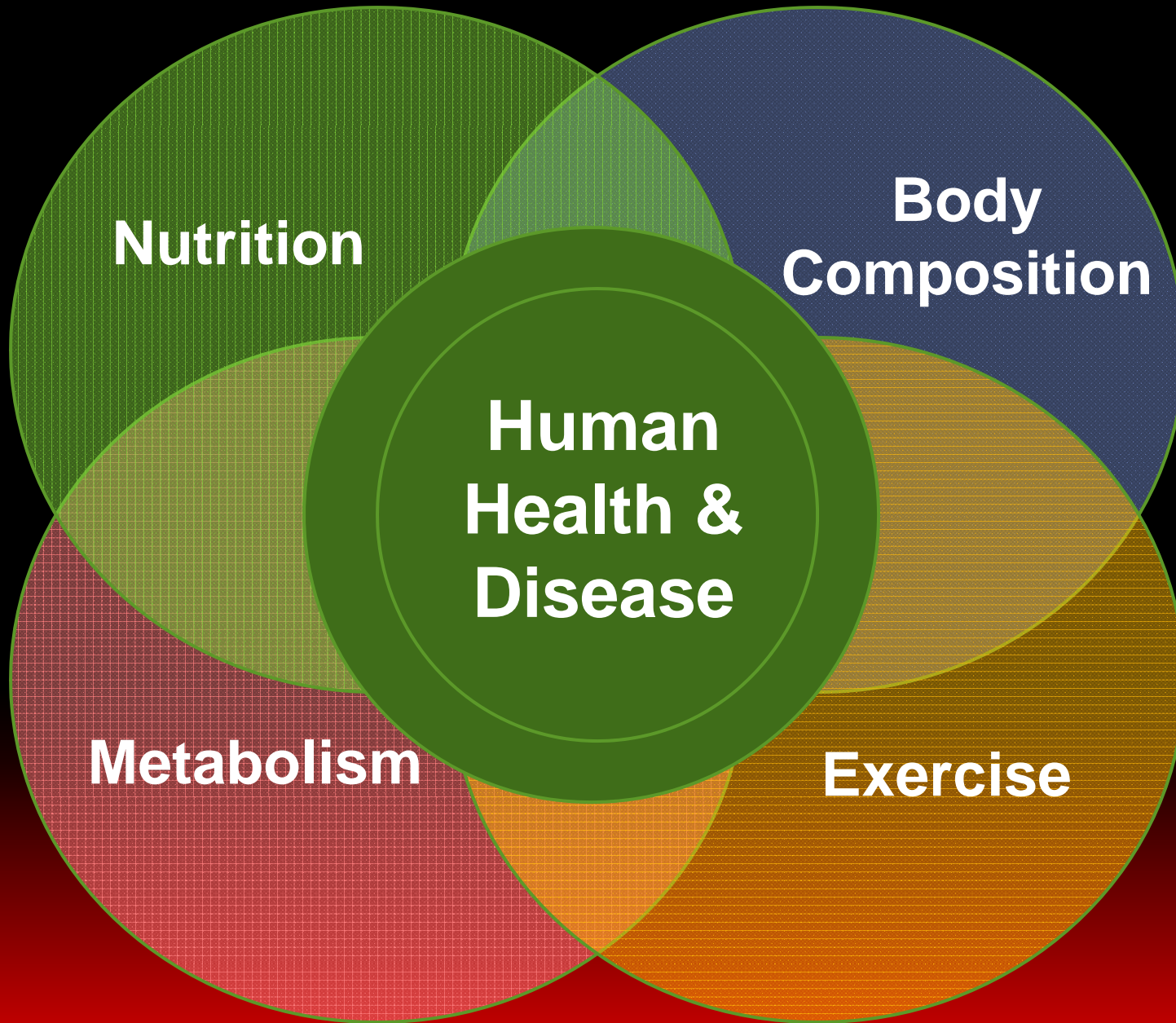


Nutrition & Exercise: A Role In The Surgical Patient?

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Learning Objectives

1. To describe the features and consequences of surgery on skeletal muscle.
2. To discuss the importance of skeletal muscle mass and function in relation to clinical outcomes.
3. To describe the role of nutrition and exercise, pre- and post-operatively, in preventing or attenuating adverse surgical outcomes.



Weight Loss is a Hallmark Feature of Surgical Patients

- High degree of diversity of weight loss
 - May depend on age, previous weight etc
- Commonly use weight
 - Expedient but crude and non-specific measure
- Loss of muscle protein cannot be discerned with weight



Precise Body Composition to Quantify Muscle Atrophy

- High precision: CT / MRI / DXA
- Characterize specific tissue mass and changes of these tissues
 - Example: Sarcopenic individuals (those with low muscularity)



Female ICU patient

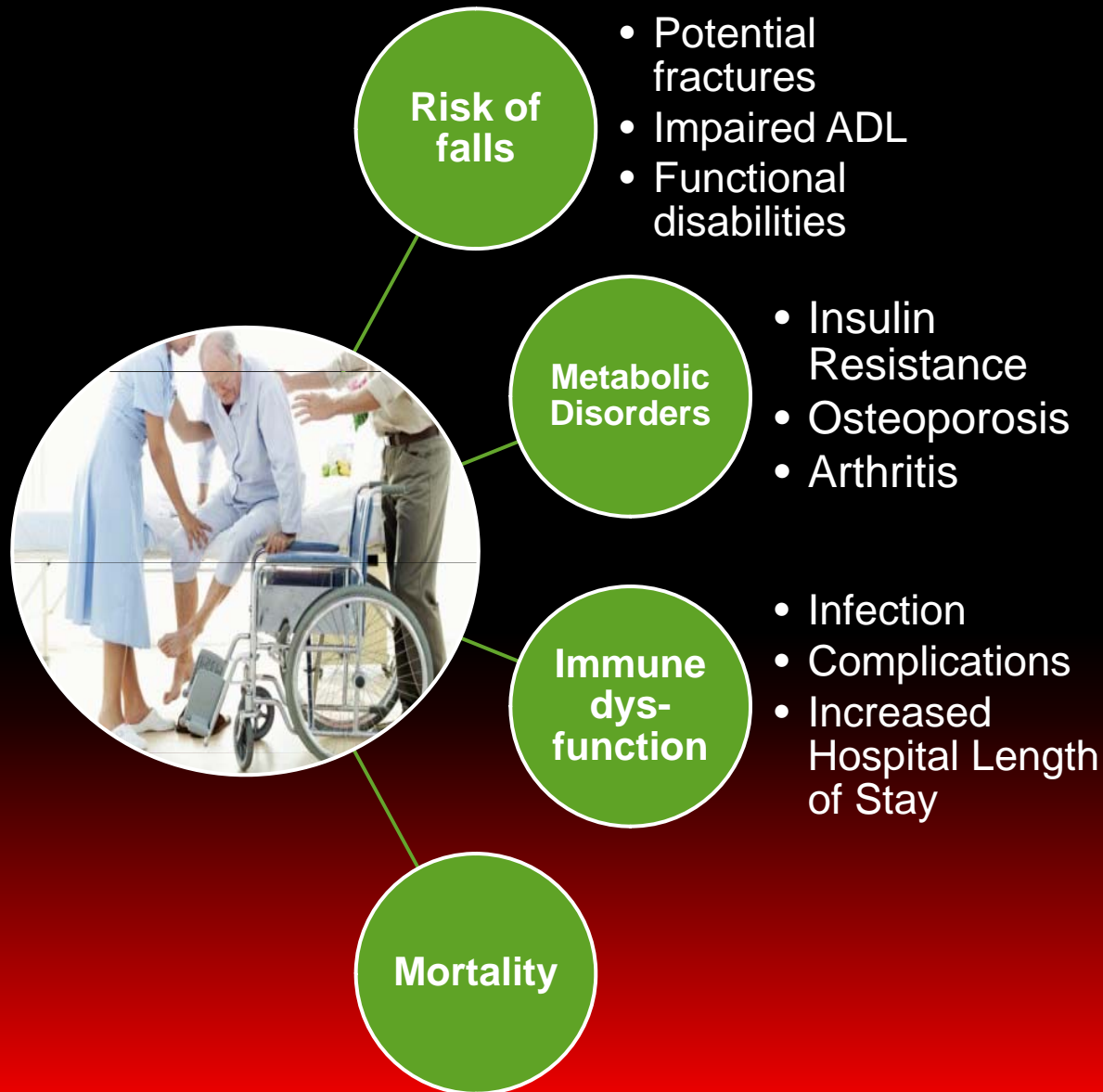


Sarcopenic with a BMI of 28.4 kg/m²

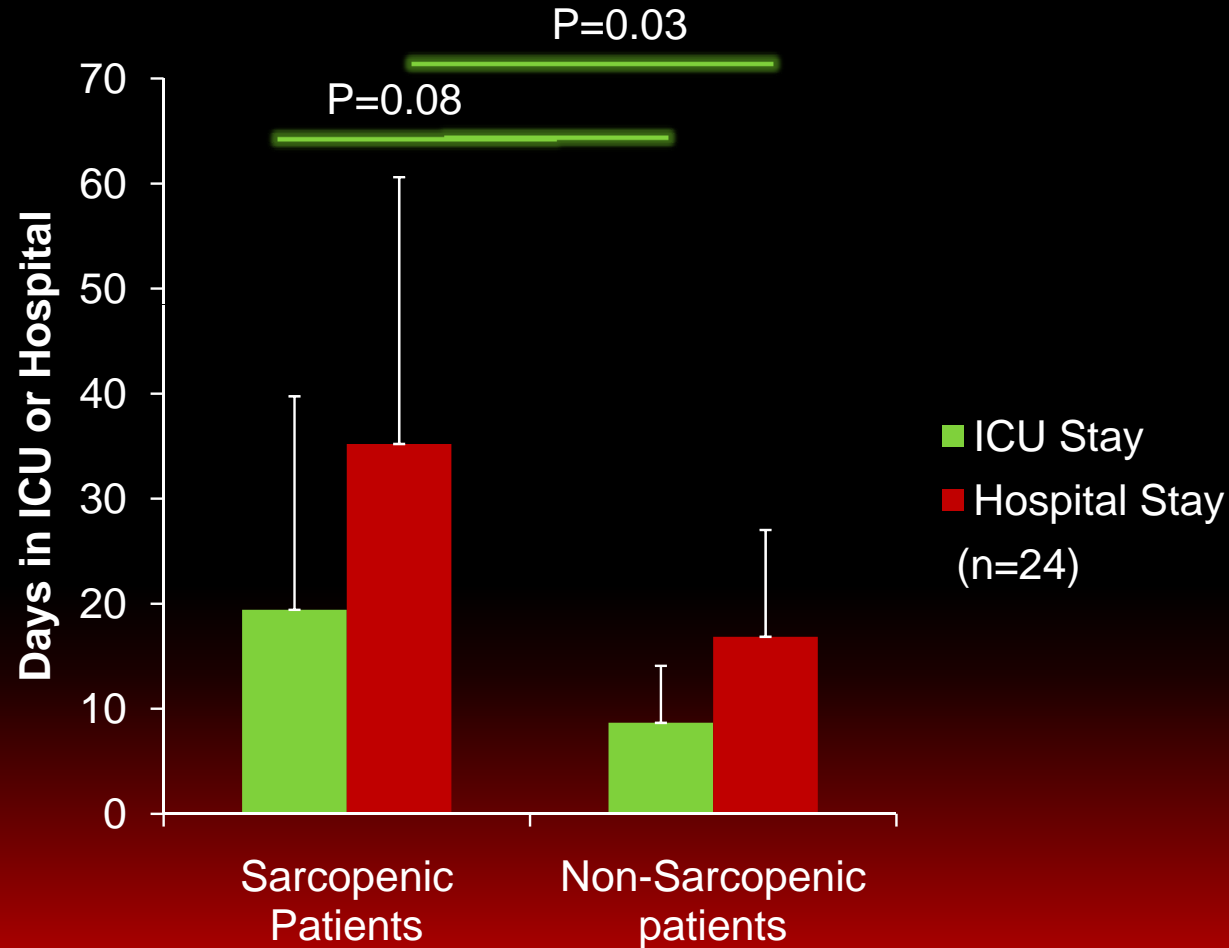
Using CT imaging to identify patients with sarcopenia

- BMI: 45-74% cancer and ICU patients are overweight or obese at admission while <5% were underweight (*Mourtzakis et al APNM 2008; Prado et al Lancet Oncol 2008; Tan Clin Can Res et al 2009; DiSebastiano et al CNS Abst 2010; Fan et al CNS Abst 2010*)
- CT imaging: Can identify sarcopenic patients (low muscularity)
 - Over 50% cancer patients and >60% ICU patients are sarcopenic at admission (*Mourtzakis et al APNM 2008; Tan et al 2009; Fan et al CNS Abst 2010*)

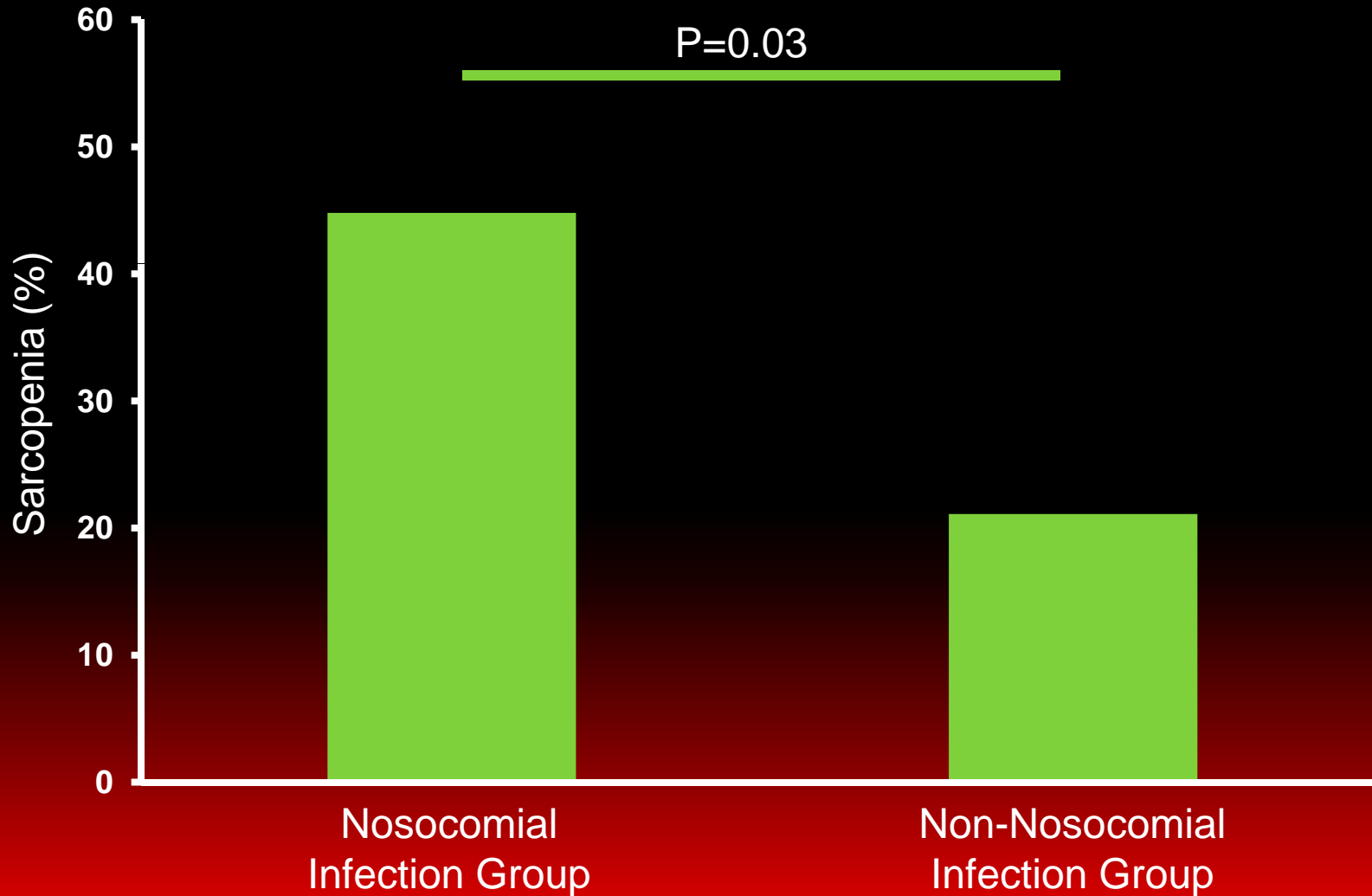
Implications of Muscle Atrophy & Sarcopenia



Sarcopenia is related to increased Hospital Stay



Sarcopenia is related to nosocomial infection in the elderly



Adopted from Cosqueric G et al Br J Nutr 2006

- Increased protein intake
- Amino acids (BCAA, gln)
- Strength Training
- Increased caloric intake



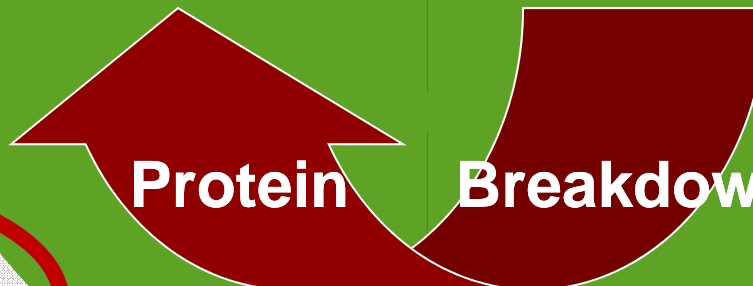
- Stimulated by insulin, IGF-1, GH, testosterone
- Inhibited by cortisol, epinephrine, glucagon

Protein Synthesis



- Inactivity
- Reduced caloric & protein intake

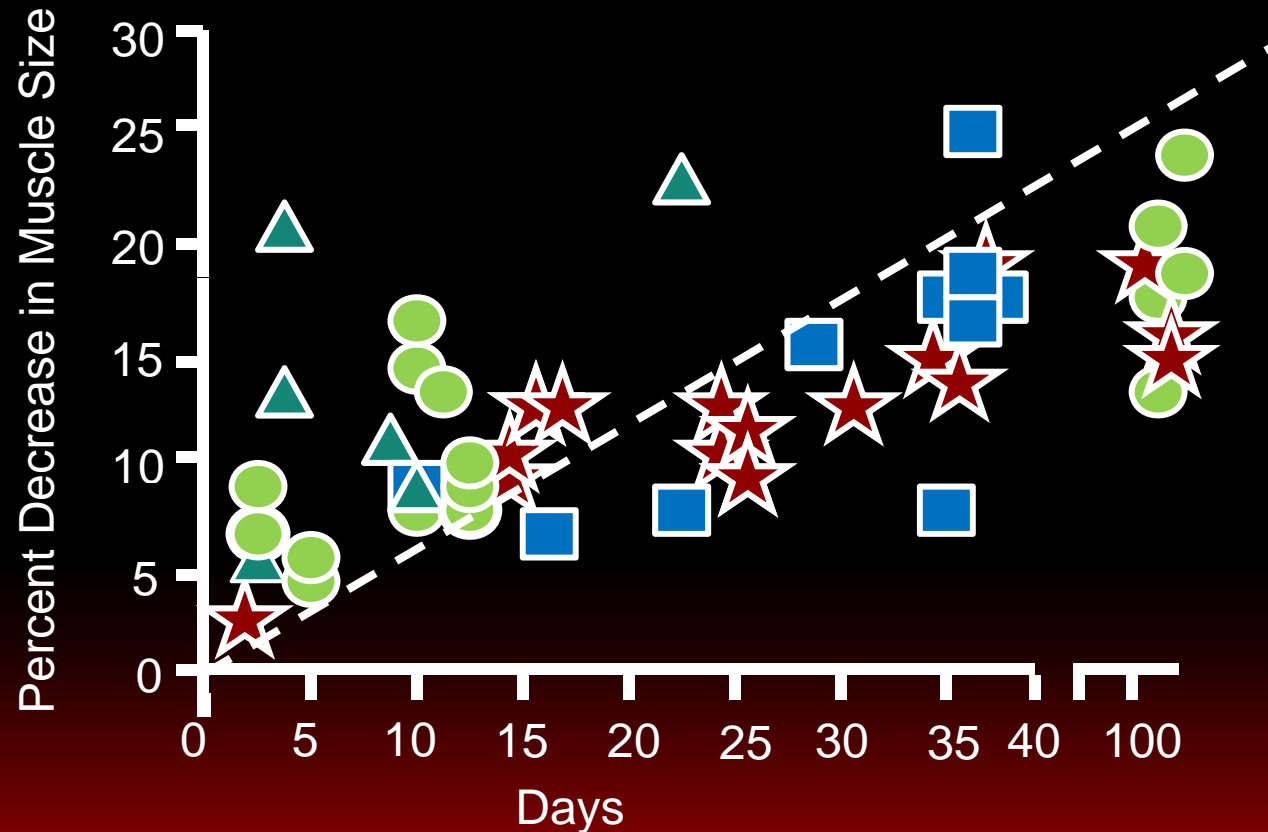
Protein Breakdown



- Stimulated by cortisol, epinephrine, glucagon, inflammation
- Inhibited by insulin, IGF-1, GH, testosterone



Muscle atrophy is related to number of days of immobilization



Space-Flight ●
Bed Rest ☆

Immobilization ▲
Unilateral Limb Suspension ■

Muscles include: knee extensors, knee flexors, triceps, gastrocnemius, soleus

Modified from Adams et al J Appl Physiol 2003



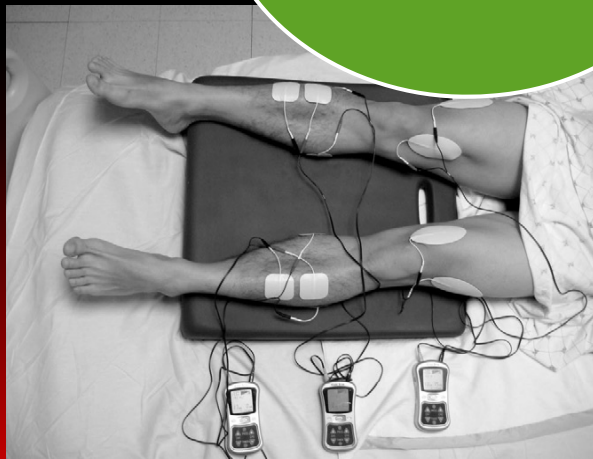
**Early
Mobilization
(Ambulation
& ADL)**



**Cycle
Ergometry**

**Electrical
muscle
stimulation**

Exercise



**Strength
Training**

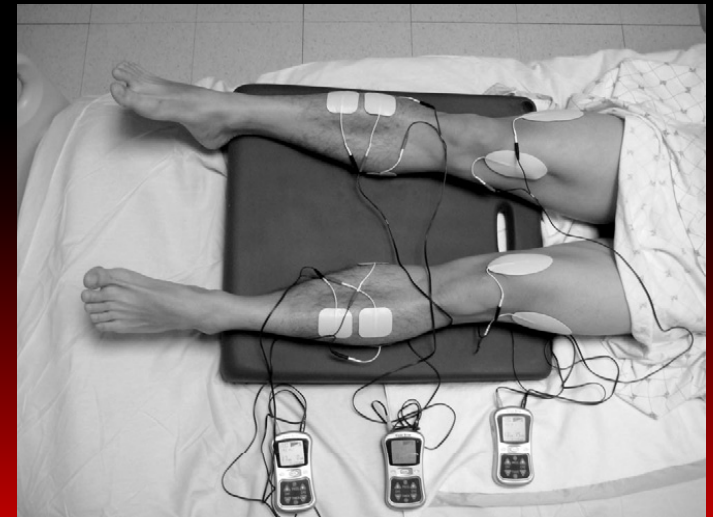


Muscle stimulation may counter muscle atrophy during immobilization

- In healthy adults during 4-10 weeks of immobilization:
 - Increase in muscle strength (*Bax et al Sports Med 2005; Maffiuletti et al J Appl Physiol 2002; Gibson et al Lancet 1988*)
 - Maintained protein synthesis rates (*Gibson et al Lancet 1988*)
- In COPD & CHF patients (4 weeks):
 - Can attenuate muscle atrophy and loss of strength
(*Gosselin et al Muscle Nerve 2003; Quittan et al Am J Phys Med Rehab 2001*)

Electrical Muscle Stimulation is also Effective in Post-operative Patients

- EMS used in post-op patients for 4-5 consecutive days
 - 1 control thigh vs 1 stimulated thigh
 - Attenuated muscle loss in stimulated leg
 - Decreased proteasome activity
 - Metabolic effects? Systemic effects?



Cardiovascular and/or Strength Training during Immobilization Studies

- Following 90 days of immobilization:
 - No exercise: muscle loss -18 to -30%
 - Resistance Training (every 3 days): muscle loss 0 to -15%

(Alkner & Tesch Eur J Appl Physiol 2004)

- Following 60 days of immobilization:
 - Bed-rest alone: ~20% muscle loss
 - Aerobic + resistance exercise: <5% muscle loss

(Trappe TA et al Act Physiol 2007)

Post-operative Exercise Rehabilitation: Cardiovascular Training

- Bedside cycle ergometry permits passive, active-assisted or active training
 - Feasible for sedated, immobile patients
 - Improved strength and physical function at discharge

(Burtin et al Crit Care Med 2009)



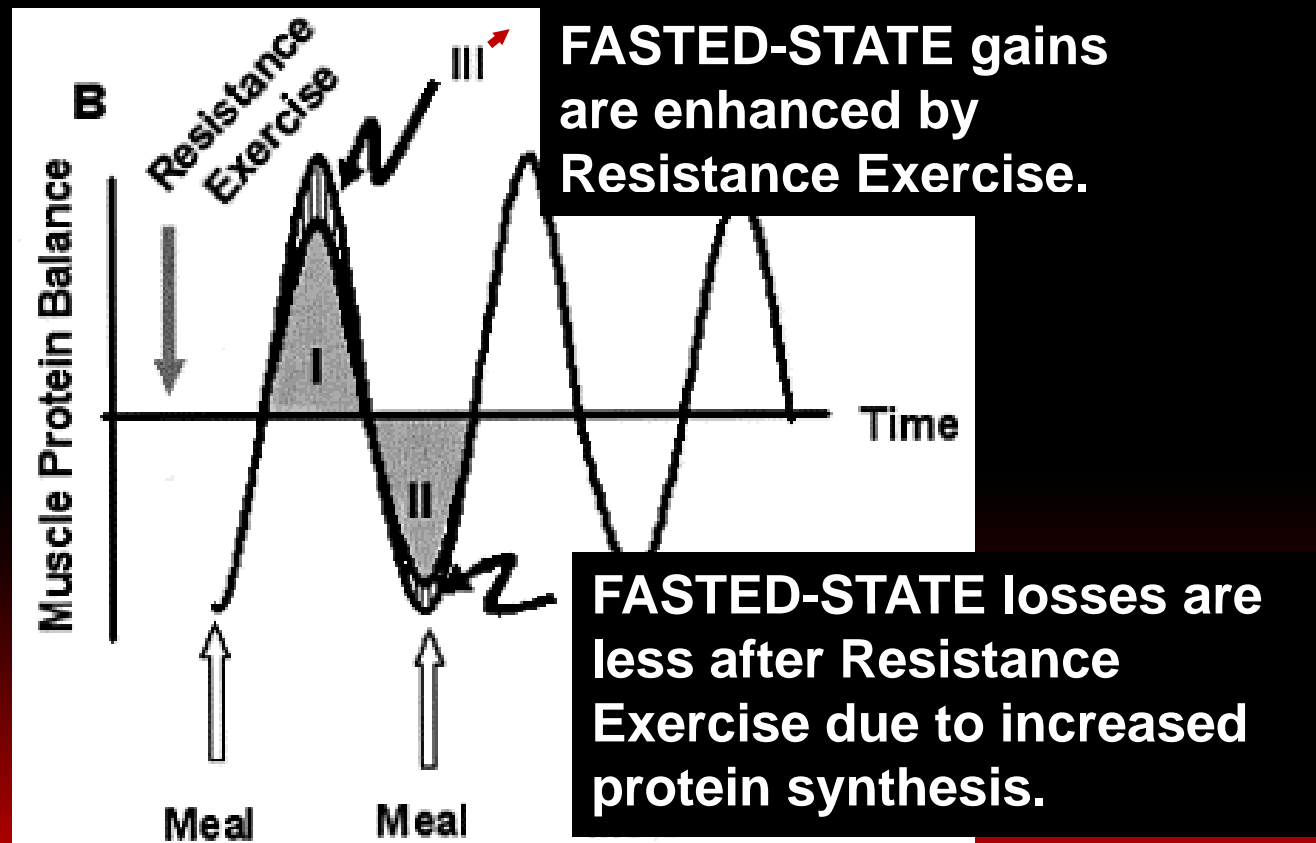
Post-operative Exercise Rehabilitation: Strength Training

- 12 weeks of strength training → increased IGF-1 expression in post-operative elderly patients, which may promote protein synthesis *(Suetta et al Growth Horm IGF Res 2010)*



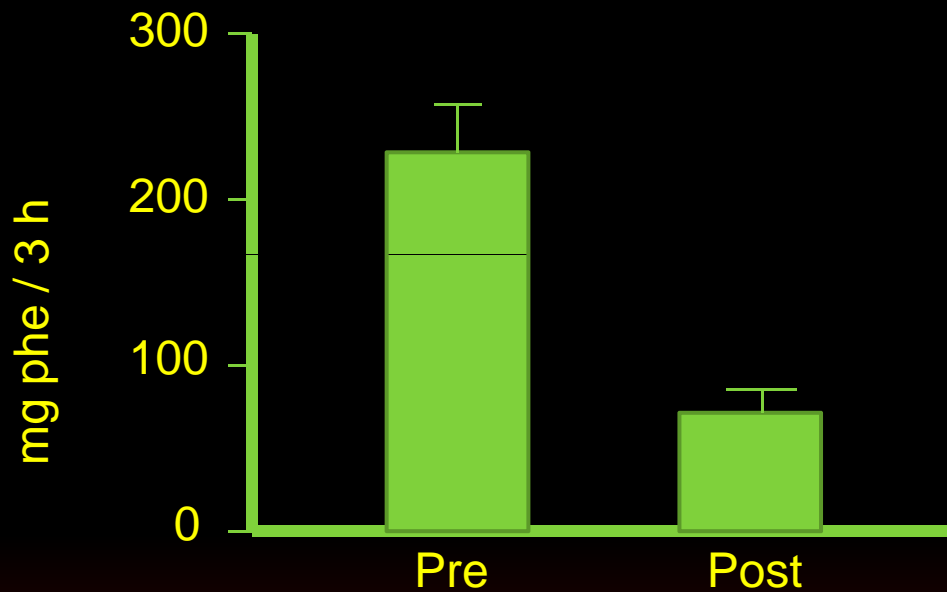
Muscle mass is maintained by activity & feeding

AUC in the FED STATE (I) = AUC in the FASTED STATE (II)



Adapted from Phillips (2004) *Nutrition* 20, 689-95.

Optimizing metabolic responses with Exercise and Nutrition



Adapted from:
Tipton et al AJP Endo Metab 2001

- 28 days of bed rest:
 - Combined amino acid intake and strength training maintained muscle mass and strength (*Brooks et al J Appl Physiol 2008*)

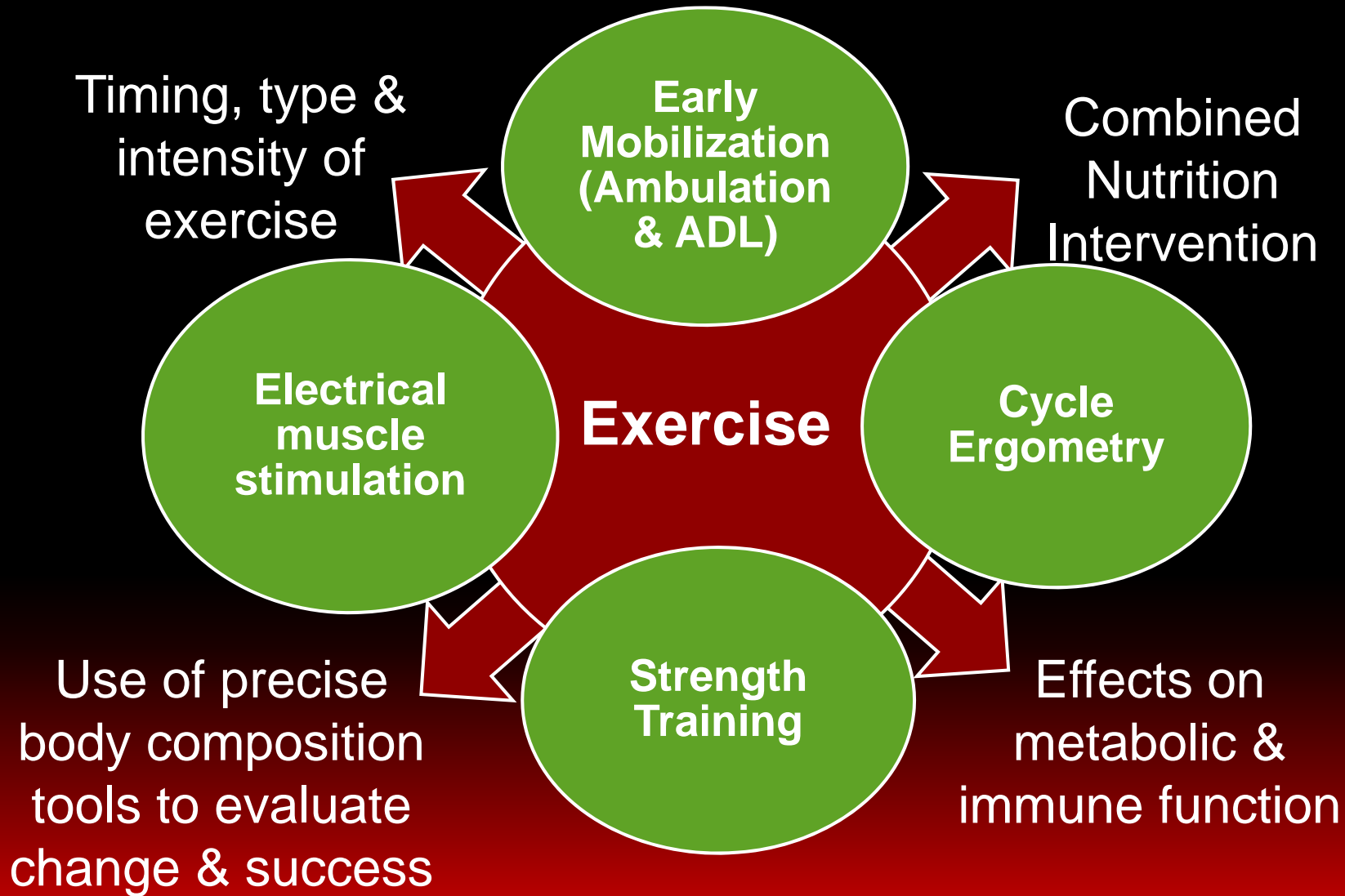
Pre-operative exercise may also be beneficial for surgical patients

- Purpose:
 - To enhance cardiorespiratory fitness and strength prior to surgery which may attenuate lean tissue loss following surgery
 - Maintain metabolic and immune function or attenuate dysfunction
 - Reduce post-operative fatigue

Pre-operative Exercise: Pre-Habilitation

- Pre-operatively cardiorespiratory fitness tests can determine peri- and post-operative:
 - Clinical complications (*Win et al Thorax 2006; Benzo et al Respir Med 2007*)
 - Overall survival (*Kohman et al JCO 2009 abstract#7518*)
- Pre-operative aerobic exercise training helped maintain cardiorespiratory fitness (*Jones et al Cancer 2007*)
- Strength training may help maintain normal levels of muscle mass during recovery

Pre- and Post-Surgery Exercise



"We can be absolutely certain only about things we do not understand." Eric Hoffer

Acknowledgements

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Lack of activity destroys the good condition of every human being, while movement and methodical physical exercise save it and preserve it. ~Plato