Exercise: special health needs (FS-11)

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Sumio Yamada (Japan)

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ICCrPT Symposium

Exercise Training/Rehabilitation for People with Special Health Needs

Session notes@: https://db.tt/51qrWAwR
Evidence about Exercise Prescription for Individuals with Obesity

Cathy Evans PhD, University of Toronto
Objectives

1. define obesity and related concepts
2. describe the evidence related to exercise for obesity
3. discuss issues about exercise for individuals who are obese
Obesity and Overweight

• Obesity characterized by excessive accumulation of body fat defined as a BMI>30
• The prevalence of overweight and obesity were highest in the WHO Regions of the Americas (62% for overweight in both sexes, and 26% for obesity) and lowest in the WHO Region for South East Asia (14% overweight in both sexes and 3% for obesity) http://www.who.int/gho/ncd/risk_factors/obesity_text/en/
• Associated secondary pathologies include diabetes, CV disease, sleep apnea, MSK - personal and societal costs
• Aetiology is complex and multifactorial
• Exercise is an important component of health – strong evidence to support the benefits of exercise
• What are the issues related to exercise prescription and obesity as a special health population?
• Why are individuals gaining weight?
Why are individuals gaining weight?

- Our ancestors exerted a great deal of energy to obtain food
- Our world is designed to minimize our need to move
- We have evolved from an existence of natural movement and physical activity to just survive to a need for intentional deliberate exercise
- Lack of physical activity linked to obesity, especially in young women \textit{Ladabaum, American J Med Aug 2014.}
- Consequences are epidemic obesity and serious secondary conditions - CV disease, diabetes and musculoskeletal related conditions
Causal Web of Factors Influencing
Weight-related Problems and the Role of the PT


International National Community Individual Populatio
Genetic studies of body mass index yield new insights for obesity biology

• “Pathway analyses provide strong support for a role of the central nervous system in obesity susceptibility and implicate new genes and pathways, including those related to synaptic function, glutamate signalling, insulin secretion/action, energy metabolism, lipid biology and adipogenesis.” A. Locke (2015)

Nature 518,2015 (12) 197–206
Medical Complications of Obesity

- Pulmonary disease
  - abnormal function
  - obstructive sleep apnea
  - hypoventilation syndrome

- Idiopathic intracranial hypertension

- Stroke

- Cataracts

- Coronary heart disease
  - Diabetes
  - Dyslipidemia
  - Hypertension

- Nonalcoholic fatty liver disease
  - steatosis
  - steatohepatitis
  - cirrhosis

- Gall bladder disease

- Gynecologic abnormalities
  - abnormal menses
  - infertility
  - polycystic ovarian syndrome

- Severe pancreatitis

- Cancer
  - breast, uterus, cervix
  - colon, esophagus, pancreas
  - kidney, prostate

- Osteoarthritis

- Skin

- Gout

- Phlebitis
  - venous stasis

http://medvin2u.net/
# Role of the PT

n=810  (You, L, Physiotherapy Canada  2011)

<table>
<thead>
<tr>
<th>Management Obesity</th>
<th>% (n) AGREE</th>
<th>Barriers</th>
<th>% (n) AGREE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assessment of Adiposity</td>
<td>43% (347)</td>
<td>Sensitivity of Subject</td>
<td>71% (561)</td>
</tr>
<tr>
<td>Weight Loss</td>
<td>67% (544)</td>
<td>Patient Motivation</td>
<td>94% (744)</td>
</tr>
<tr>
<td>Cardiorespiratory Training</td>
<td>95% (766)</td>
<td>Not a client goal</td>
<td>83% (657)</td>
</tr>
<tr>
<td>Prescribe Equipment</td>
<td>76% (618)</td>
<td>PT Experience</td>
<td>81% (608)</td>
</tr>
<tr>
<td>Functional Mobility</td>
<td>97% (781)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Exercise Prescription</td>
<td>96% (780)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Associated Conditions</td>
<td>95% (771)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wt. loss (pre-surg)</td>
<td>74% (599)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Consensus of Role in PT

• Our second study was a consensus study: Achieving Consensus on Recommendations for the Clinical Management for Overweight and Obese Adults for Canadian Physiotherapy Practice (Alexander, Rosenthal and Evans, Phys Canada 2012:64(1))

• Our findings - Consensus that PT practice should include:
  – Assessment of medical history
  – Exercise training and progression of exercise
  – Exercise testing and evaluation of physical activity
  – Calculation of BMI
  – Education on strategies to improve adherence to exercise
Weight Stigma (negative attitude)

- Evidence suggests health care professionals, especially young females have a strong weight bias and may blame individuals (Schwartz Obes Res11(9) 2003)
- Complexity of issue - Bogart, 2014 Regulating Obesity?
- Cross section survey of PTS in Australia – demonstrated that an explicit weight stigma exists among PTs (Setchell. Journal of Physiotherapy 2014;60:157-162)
- Reflect a lack of understanding of complex factors that contribute to obesity, such as economic status, community environment, and genetics
- Studies confirm the need for individual reflection on one’s personal belief and education in entry level programs
Prevention and Management
Exercise Prescription

• 96% of the PTs in our Canadian survey felt that PTs had a role to play in exercise prescription for patients who were overweight or obese
  – Is there evidence to suggest that exercise can help to prevent and manage obesity in adults and children? General, CR, Diabetes, CVA
  – What are the principles of exercise for clients who are obese or overweight
Systematic Reviews Evidence

- Schwingshacki 2014 - Diet + exercise
- Vissers, 2013 - Aerobic exercise
- Curioni 2005 - D+E 20% more weight loss -D alone
- Catenacci 2007 - effective higher levels of ex alone needed
- Miller – 152 studies – diet plus ex 8.6 kg one year
- Cochrane – Shaw 2006 – diet plus high intensity exercise resulted in greater red’n in weight, BP, serum lipids
Schwingshacki et al 2014

• Diet + exercise more effective in reducing BW and BP and improving WC, WHR and FM, VO$_2$max
• D+E reduced all cause mortality by 14% and CVD/CHD by 16%
• Diet alone is better than Exercise alone – BW
The effect of exercise on visceral adipose tissue in overweight adults: a systematic review and meta-analysis.

(Vissers, 2013)

• Review – 87 articles

• Aerobic training of moderate or high intensity has the highest potential to reduce visceral adipose tissue in overweight males and females

• These results suggest that an aerobic exercise program, without hypocaloric diet, can show beneficial effects to reduce visceral adipose tissue with more than 30 cm (on CT analysis) in women and more than 40 cm in men, even after 12 weeks
Role of Exercise in Weight Management – It’s about Energy

• Weight loss through energy balance – reduced energy intake and increased energy expenditure through exercise and physical activity. Weight may not be the best outcome

• Exercise also improves:
  – bone health
  – skeletal muscle
  – Stress and reduces cortisol – leads to fat storage
  – Improves heart health
Energy Balance

• Primary pathology behind excess weight gain was thought to be related to imbalance too many calories for the amount of energy expenditure
• Genetics, environmental factors, conditions technology, knowledge versus manual work, diet, fast food, denial
• Reduce energy intake: by 500-1000kcal/day
For 7 days = reduction of 3500 kcal/week or approximately 1 lb.
Physical Activity Adults 18-64

Recommended to improve CR and MSK fitness and reduce risk.

1. Minimum 150 minutes of moderate-intensity aerobic physical activity throughout the week, or minimum 75 minutes of vigorous-intensity aerobic physical activity or combination

2. Progression - Aerobic activity should be performed - at least 10 minutes duration and increase their moderate-intensity aerobic physical activity to 300 minutes per week, or engage in 150 minutes of vigorous-intensity aerobic physical activity/week, or an equivalent moderate- and vigorous

3. Muscle-strengthening activities should be done involving major muscle groups on >2 days/week. (2010)
• 2 hours and 30 minutes (150 minutes) each week of moderate-intensity aerobic activity OR 1 hour and 15 minutes (75 minutes) of vigorous-intensity aerobic activity (i.e., jogging or running) every week AND

• Weight training muscle-strengthening activities on 2 or more days a week that work all major muscle groups (legs, hips, back, abdomen, chest, shoulders, and arms)

• [Link](http://www.cdc.gov/physicalactivity/everyone/guidelines/adults.html)
Exercise Considerations

- Injury
- Sensitivity
- Behavioral change – assessment
- More than gym memberships, sports teams and high energy sports
- Integrate movement and exercise into lifestyle
Obesity and Injury

Cross Sectional study
The research analysed data associated with medically treated injuries of 7,690 workers over 3 years. 29% injured at least once

Injuries - 15% for normal and 85% overweight or obese
42,304 overweight and obese individuals (as defined by having a BMI of more than 25).

Overweight people were 15% more likely to have an injury, while obese people were 48% more likely. Types of injuries included sprains, strains, joint dislocations, falls and fractures of the legs, ankles and feet.


May/June 2007 issue of Journal of Health Promotion
Minimal exercise can counteract sedentary lifestyle.  

Toronto Star – Canadian newspaper  

Dina Brooks University of Toronto, Published on Mon Mar 30 2015

23 and a ½ hours. Dr. Mike Evans,

https://www.youtube.com/watch?v=aUaInS6HIGo
Obesity and Fitness

• Cardio-resp fitness modifies relation to adiposity as measured by BMI to mortality eg Men of healthy weight (BMI) who were not fit had higher risk of all cause mortality

• McAuley et al followed 9563 men with heart disease 1977-2002
  (Mayo clinic Proceedings 2012 87-5)
PT Role in Prescription

Individuals who are morbidly obese should be:

• Cautious of orthopaedic stresses.
• Start with non-weight-bearing exercises (eg, swimming, water aerobics, floor exercises).
• Avoid high-impact aerobic activities.
• Emphasize duration as tolerated and exercise frequency (sessions per week).
• Emphasize pre-meal exercise, especially exercise in the morning before eating breakfast to mobilize fats (lipolysis)
• Explore Reduced Sitting Time (van der Ploeg, 2012)
Assessment/Screening

- Awareness – BMI/waist circumference monitoring - Regular height weight monitoring, ...at risk
- Lifestyle – find a measure???
- Lab work – family doc – fasting glucose, fasting lipid profile
- Goal – fitness and health not weight loss
Conclusions

• Obesity is a significant health concern globally
• PTs have an important role to play
• Exercise and diet is effective in short and long term weight maintenance and loss (more than diet or exercise alone)
• Body weight might not be the optimum sole outcome measure to evaluate when examining the health benefits of an exercise intervention.
• Considerations for this special population exercise prescription include:
  – screening for risk factors eg injury, CV
  – behavior and lifestyle modifications
  – gradual progression and duration before increasing intensity
  – Integrating exercise as a “normal” part of lifestyle
Functional Decline after Cardiovascular Surgery
– New perspective of muscle proteolysis —

Sumio Yamada
Nagoya University Graduate School of Medicine
Department of Rehabilitation Sciences
Scope of Talk

1. Muscle proteolysis induced by CV surgery

2. Preventive trial using NMES
Muscle weakness occurs systemically after CV surgery.

Figure 3. Mean percent change in muscle strengths after surgery (POD 7 and 14). *P < 0.01. **P < 0.05.

POD; post-operative day  GS; grip strength  MIP; maximum inspiratory pressure
MEP; maximum expiratory pressure, KEIS; knee extensor isometric strength.

Why systemically?
Inflammation may affect postoperative muscle weakness.

Relationship between Log IL-6 and $\Delta$GS (A), and $\Delta$MIP (B), and $\Delta$MEP (C).

(lida Y, Yamada S, J Crit Care. 2009)
Schematic of the main molecular pathways balancing muscle protein synthesis and breakdown

(Sepis, inflammation, immobility)

**Pathways decrease**
- IGF-1
- Akt
- FoxO
- FoxO-P
- mTOR
- MAP Kinase

**Protein synthesis** ↓ ↓ **Muscle atrophy**

**Pathways increase**
- Myostatin
- Structured myofilament
- Calpains/caspases
- Myosin
- Ubiquitin
- Ubiquitin ligases

**Protein breakdown** ↑ ↑

(3-methylhistidine)

Patients in the ICU develop muscle weakness by operation stress.

- Inhibition of protein synthesis
- Apoptosis of myonuclei within muscle fibers

↓Muscle volume

- Acceleration of muscle proteolysis
- Apoptosis of myonuclei within muscle fibers

Muscle weakness

Letter to the Editor

Postoperative muscle proteolysis affects systemic muscle weakness in patients undergoing cardiac surgery

Yuki Iida a, Takenori Yamazaki b, Tsutomu Kawabe c, Akihiko Usui d, Sumio Yamada e, *

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b Department of Cardiovascular Surgery, Keihan Hospital, 296 Minamihozen, Maegashico, Yatomi, #388-8502, Japan
c Department of Medical Technology, Nagoya University Graduate School of Medicine, 1-1-20 Daiko-minami, Higashi-ku, Nagoya, #461-8673, Japan
d Department of Cardiovascular Surgery, Nagoya University Graduate School of Medicine, 1-1-20 Daiko-minami, Higashi-ku, Nagoya, #461-8673, Japan
e Department of Rehabilitation Science, Nagoya University Graduate School of Medicine, 1-1-20 Daiko-minami, Higashi-ku, Nagoya, #461-8673, Japan
Interleukin-6 (A) and cortisol (B) were significantly increased at 4 hours after surgery.

* $P < 0.01$. ** $P < 0.05$. IL-6; Interleukin-6, Pre; preoperative, 4hr PO; 4 hour postoperative, POD1; postoperative day 1.
Anabolic indicators were depressed early after surgery.

BCAA to AAA ratio (BCAA/AAA) and IGF-1 to growth hormone ratio (IGF-1/GH) were significantly decreased at post-operative day 1.

*P < 0.01. **P < 0.05. BCAA; branched chain amino acids, AAA; aromatic amino acids, IGF-1; insulin-like growth factor-1, Pre; operative, 4hr PO; 4 hour postoperative, POD1; postoperative day 1.
Schematic of the main molecular pathways balancing muscle protein synthesis and breakdown

Muscle proteolysis accelerates within 48 hours after surgery.

*P < 0.01 vs POD1. 3MH; 3-methylhistidine, Cre; creatinine, POD; postoperative day.

Relationship between muscle weakness on POD 14 and 3MH/Cre

Muscle proteolysis did occur and accelerated 48-72 hours after CV surgery, suggesting a target period to initiate preventive intervention for skeletal muscle decline.
SCOPE OF TALK

1. Muscle proteolysis induced by CV surgery

2. Preventive intervention using NMES
48 hours?

- Hemodynamic instability
- Sedation
- Surgical injury
- Malnutrition
Neuromuscular electrical stimulation: NMES

Figure 1. Transcutaneous NMES of the mm. quadriceps femoris in a male patient with COPD (GOLD stage IV). Written patient consent was obtained for use of this photograph.

(Sillen MJH, et al. CHEST.136:44–61 2009)
Is NMES effective against post-surgical muscle proteolysis?
# Neuromuscular Electrical Stimulation: NMES

<table>
<thead>
<tr>
<th>Study</th>
<th>Study population</th>
<th>Intervention duration</th>
<th>Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kehlet H, et al 1996</td>
<td>N=13 Abdominal operation</td>
<td>POD5</td>
<td>↑ Muscle cross-sectional area</td>
</tr>
<tr>
<td>Gerovasili V, et al 2009</td>
<td>N=49 ICU patient</td>
<td>9 d after ICU</td>
<td>↑ Muscle cross-sectional area</td>
</tr>
<tr>
<td>Strasser EM, et al 2009</td>
<td>N=26 Abdominal operation</td>
<td>POD 4</td>
<td>↓ Muscle proteolysis</td>
</tr>
</tbody>
</table>
NMES prevent muscle proteolysis.

Subjects; Abdominal operation (N=26)
NMES: 30 min/d, POD1-POD4

Caution!

NMES has adverse effects.
Low frequency fatigue (LFF)

Definition: Diminishing of contractile responses to low-frequency stimulation.


Mechanism;

【Abnormal Ca²⁺ regulation】

【Measurement of LFF】


![Graph showing Ca²⁺ release, uptake, and ATPase activities before and after LFF measurements.](image_url)
Depression of Ca$^{2+}$ uptake in elderly and CHF patients

<table>
<thead>
<tr>
<th></th>
<th>Young female</th>
<th>Elderly female</th>
</tr>
</thead>
<tbody>
<tr>
<td>$RT_{1/2}$, ms</td>
<td>45 ± 1</td>
<td>59 ± 2†</td>
</tr>
<tr>
<td>$PR_{int}$, %/ms</td>
<td>-5.1 ± 0.1</td>
<td>-3.9 ± 0.2†</td>
</tr>
<tr>
<td>Ca$^{2+}$ uptake, nmol·mg protein$^{-1}$·min$^{-1}$</td>
<td>10.5 ± 0.6</td>
<td>7.1 ± 0.8†</td>
</tr>
<tr>
<td>Ca$^{2+}$-ATPase activity, nmol·mg protein$^{-1}$·min$^{-1}$</td>
<td>80.3 ± 4.1</td>
<td>51.1 ± 3.8‡</td>
</tr>
<tr>
<td>Type I area, %</td>
<td>54.3 ± 2.2</td>
<td>60.9 ± 2.3*</td>
</tr>
<tr>
<td>Type II area, %</td>
<td>45.7 ± 2.2</td>
<td>39.1 ± 2.3*</td>
</tr>
</tbody>
</table>


![Graph showing calcium uptake in control and fatigue conditions for CHF and Sham rats.](image-url)
Development of LFF-free waveform

Conventional waveform

- **Intensity:** 15% MVC
- **Pulse-group:** 20Hz
- **Pause:** 50ms
- **Pause:** 40s

Prevalence of LFF: **4 out of 11**

Newly-developed waveform

- **Intensity:** 15% MVC
- **Pulse-group:**
- **Pause:** 30s

Prevalence of LFF: **0 out of 11**
Is NMES safe?

- Hemodynamic instability
- Sedation
- Surgical injury
- Malnutrition
Feasibility of Neuromuscular Electrical Stimulation Immediately After Cardiovascular Surgery

Kotaro Iwatsu, PT, MSc, a Sumio Yamada, PT, PhD, b Yuki Iida, PT, MSc, a,c Hideyuki Sampei, PT, MSc, a Kiyonori Kobayashi, PT, MSc, d Motoshi Kainuma, MD, PhD, e Akihiko Usui, MD, PhD f

From the aProgram in Physical and Occupational Therapy and the bDepartment of Rehabilitation Science, Nagoya University Graduate School of Medicine, Nagoya; cDepartment of Physiotherapy, Kainan Hospital, Aichi; dDepartment of Rehabilitation and the eSurgical Intensive Care Division, Nagoya University Hospital, Nagoya; and the fDepartment of Cardiac Surgery, Nagoya University Graduate School of Medicine, Nagoya, Japan.
NMES for patients with aortic surgery  (POD1)
## Cardiovascular response at 1st EMS session

<table>
<thead>
<tr>
<th>Variable</th>
<th>CV at rest</th>
<th>∆10min</th>
<th>∆20min</th>
<th>∆30min</th>
<th>∆40min</th>
<th>∆50min</th>
<th>∆60min</th>
<th>CV at EMS</th>
</tr>
</thead>
<tbody>
<tr>
<td>SBP</td>
<td>106.7</td>
<td>3.5</td>
<td>3.3</td>
<td>3.3</td>
<td>1.3</td>
<td>2.7</td>
<td>0.3</td>
<td>1.3</td>
</tr>
<tr>
<td></td>
<td>(97.3-112.7)</td>
<td>(2.1-5.5)</td>
<td>(-1.7-7.3)</td>
<td>(-3.7-6.0)</td>
<td>(-11.6-14.3)</td>
<td>(-0.9-5.8)</td>
<td>(-5.3-4.7)</td>
<td>(-5.3-4.7)</td>
</tr>
<tr>
<td>HR</td>
<td>84.7</td>
<td>1.3</td>
<td>0.0</td>
<td>0.7</td>
<td>0.0</td>
<td>1.0</td>
<td>0.7</td>
<td>1.3</td>
</tr>
<tr>
<td></td>
<td>(74.7-92.0)</td>
<td>(0.7-2.6)</td>
<td>(-1.3-1.7)</td>
<td>(-0.3-3.0)</td>
<td>(-1.3-2.3)</td>
<td>(-1.0-3.3)</td>
<td>(-1.0-3.3)</td>
<td>(-1.3-3.7)</td>
</tr>
</tbody>
</table>

sysBp, systolic blood pressure; HR, heart rate; CV, coefficient of variance. Data are presented as median (interquartile range)

### Criteria for Success of Feasibility and Associated Outcomes

<table>
<thead>
<tr>
<th>Variable</th>
<th>Criteria for Success of Feasibility</th>
<th>Study outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compliance</td>
<td>&gt;80% of participants complete ≥4 of 5 sessions</td>
<td>61 of 68 (89.7%)</td>
</tr>
</tbody>
</table>

**Cardiovascular response to EMS**

- **Change in systolic blood pressure**: In all participants, changes in systolic blood pressure from rest to EMS do not exceed 20mmHg
  - Study outcome: 100%

- **Change in heart rate**: In all participants, changes in heart rate from rest to EMS do not exceed 20bpm
  - Study outcome: 100%

- **Insidence of new onset atrial fibrillation**:
  - < 30% in CABG group: 7 of 26 (26.9%)
  - < 40% in valvular surgery group: 4 of 22 (17.4%)
  - < 50% in aortic or combined surgery group: 4 of 20 (20.0%)
Effects of Neuromuscular Electrical Stimulation on Functional Decline in Patients after CV Surgery - Multicentre Randomized Controlled Trial -

Sumio Yamada¹, Kuniyasu Kamiya², Yuki Iida³, Kotaro Iwatsu, Takenori Yamazaki³, Kentaro Kamiya⁴, Akira Miyachi⁴, Kiyonori Kobayashi⁵, Akira Usui A⁵, Daisuke Sakui⁶, Koji Ueyama⁶, Satoshi Watanabe⁷, Takeshi Miyairi⁷

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Study protocol

NMES
(30-60 min/d, 5 days/week, POD1-POD14)

admission → Operation → Discharge

Pre-operative assessment

POD 14d

F/U at 3 mo post-discharge
## Patients Characteristics

<table>
<thead>
<tr>
<th></th>
<th>NMES (n = 25)</th>
<th>Control (n = 32)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, years</td>
<td>75.9 ± 4.3</td>
<td>75.7 ± 3.8</td>
<td>0.848</td>
</tr>
<tr>
<td>Men, n (%)</td>
<td>21 (84.0%)</td>
<td>23 (71.9%)</td>
<td>0.279</td>
</tr>
<tr>
<td>Comorbidity, n (%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hypertension</td>
<td>15 (60.0%)</td>
<td>19 (59.4%)</td>
<td>0.962</td>
</tr>
<tr>
<td>Diabetes Mellitus</td>
<td>12 (48.0%)</td>
<td>16 (50.0%)</td>
<td>0.881</td>
</tr>
<tr>
<td>Dyslipidemia</td>
<td>13 (52.0%)</td>
<td>16 (50.0%)</td>
<td>0.881</td>
</tr>
<tr>
<td>CKD</td>
<td>7 (28.0%)</td>
<td>8 (25.0%)</td>
<td>0.799</td>
</tr>
<tr>
<td>COPD</td>
<td>2 (8.0%)</td>
<td>3 (9.4%)</td>
<td>0.856</td>
</tr>
<tr>
<td>Cerebro Vascular Disease</td>
<td>7 (28.0%)</td>
<td>3 (9.4%)</td>
<td>0.067</td>
</tr>
<tr>
<td>Type of surgery</td>
<td></td>
<td></td>
<td>0.543</td>
</tr>
<tr>
<td>CABG</td>
<td>11 (44.0%)</td>
<td>18 (56.3%)</td>
<td></td>
</tr>
<tr>
<td>Valvular</td>
<td>13 (52.0%)</td>
<td>12 (37.5%)</td>
<td></td>
</tr>
<tr>
<td>Others</td>
<td>1 (4.0%)</td>
<td>2 (6.3%)</td>
<td></td>
</tr>
<tr>
<td>Dangling (POD)</td>
<td>2.08 ± 1.00</td>
<td>2.19 ± 1.35</td>
<td>0.741</td>
</tr>
<tr>
<td>100m walk (POD)</td>
<td>6.46 ± 4.27</td>
<td>5.78 ± 2.35</td>
<td>0.452</td>
</tr>
<tr>
<td>Discharge (POD)</td>
<td>20.17 ± 6.23</td>
<td>19.83 ± 5.25</td>
<td>0.832</td>
</tr>
</tbody>
</table>
Change ratio of Isometric Knee Extensor Strength

- **NMES (n=25)**
  - Pre-operation: 0.924, P = 0.980
  - POD14: 0.926, P = 0.218

- **Control (n=32)**
  - Pre-operation: 1.000, P = 0.088
  - POD14: 0.912, P = 0.105

Paired t-test
Unpaired t-test
Change ratio of 10m usual walk speed

<table>
<thead>
<tr>
<th>Intervention (n=25)</th>
<th>Control (n=32)</th>
</tr>
</thead>
<tbody>
<tr>
<td>P = 0.048</td>
<td>P = 0.001</td>
</tr>
<tr>
<td>Paired t-test</td>
<td>Unpaired t-test</td>
</tr>
</tbody>
</table>

POD14
10m usual walk speed

NMES (n=25)

Control (n=32)

P = 0.954

P < 0.001
Correlation between 10m usual walk speed and 6min walk distance in preoperative patients

$Y = 237.9 \times + 119.2$

$P < 0.001$

$R^2 = 0.5664$
Take Home Message

- Muscle proteolysis did occur and accelerated 48-72 hours after CV surgery, suggesting a target period to initiate preventive intervention for skeletal muscle decline. NMES will be a potential strategy against postoperative muscle decline, particularly in patients with low functional reserve.
Exercise in Patients with Critical Illness

Natascha Plani (MSc)
Sklaar Laidler and Associates
Johannesburg, South Africa
“I am troubled when I make rounds in critical care units today because of the grotesque and inhuman scenarios that I so frequently encounter... what I see these days are paralysed, sedated patients, lying without motion, appearing to be dead, except for the monitors that tell me otherwise...

When we first started our unit in 1964, patients who required mechanical ventilation were awake and alert and often sitting in a chair eating food,... these individuals could interact with their family, friends and environment... By contrast, patients with induced coma and paralysis cannot even maintain muscle tone...”

Thomas Petty, 1998
• Being alive and/or off ventilator frequently sole endpoint of critical care
• Focus in ICU on recovery of acute organ system failure
• Treatment of circulatory, respiratory and renal dysfunction
• Little attention to neuromuscular function
• Mortality, organ dysfunction and physiological endpoints used for evaluation
• Short-term outcomes

ICU Survival

- Short-term outcomes of critically ill patients improved dramatically in recent years
- ICU survivors in increasing numbers - survival rate 89% at hospital discharge
- Survivors of MV
  - Often poor physical outcomes
  - ICU re-admissions
  - Institutionalization
  - Decreased health-related QOL
  - Increased mortality

Post Intensive Care Syndrome

Survivor (PICS)

Mental Health

Cognitive Impairments

Physical Impairments

Family (PICS)

Mental Health

Needham et al 2011 CCM
Critical Illness

- Severely compromised systems
- CVS instability
- SIRS, MODS
- Inflammatory state
- Medication to manage pathological processes
- Induced coma, heavy sedation
- Prolonged mechanical ventilation
- Prolonged immobility
Bed Rest

- Creates pro-inflammatory state
- Increased proteolysis, decreased protein synthesis
- Muscle mass loss of 1 - 2% per day in first 2-3 weeks
- Immobilisation by casting – muscle mass loss 5 – 6%/day
- ARDS patients – 18% body weight loss
- Decreased size of muscle fibres

Effects of Immobility Even in Short term

- 1/52 ICU stay:
  - 67% of patients severely dependent
  - 73% unable to walk independently
- Critically ill often ventilated and sedated much longer
- Patients who stay in ICU >2 days – long lasting restrictions in physical, psychological and social function

Hopkins and Spuhler 20009, Walker et al 2015
Long-term Ventilation in Trauma Patients

- Young population
- MV > 5 days - significant limitations in exercise capacity, muscle strength and physical components of QOL up to 6 months post-discharge
- Persistent impairment of function is related to duration of illness and immobility

Van Aswegen et al 2010
Consequences

- Severe persistent limitations in upper and lower extremity strength for months to years following critical illness
- Motor and sensory deficits
- Difficulty with walking
- Difficulty with ADL
- Neuropsychological dysfunction
- Long term cognitive impairments
Consequences

- Profound and persistent deterioration of physical function and QOL – major disability
- Long arc of recovery post-ICU and discharge
- Recovery often incomplete
- Patients admitted for physiologic instability, but remain institutionalized due to limitations in self-care abilities

Poulsen et al 2013
• Increased morbidity, mortality, cost of care
• Requires long-term rehabilitation
• Cost and extent of services required, including rehabilitation facilities and home visits could be more expensive than acute care

Schweikert et al 2009
Weakness in Critical Illness

• Secondary muscle atrophy – wasting plus secondary pathological insult-like inflammation
• Protein catabolism - imbalance in protein synthesis and degradation
• Evident in fast and slow twitch fibers
• Rapid deterioration of antigravity muscles
• Affects muscles of posture and used to transfer position

• Functional denervation - decreased frequency and intensity of muscle impulses
• Skeletal muscle membrane inexcitability
• Smaller muscle cross-sectional area, not reduced force generated per area

Bed rest/inactivity

Muscle mass loss/atrophy

Sepsis

Systemic inflammation response syndrome

Microcirculation deterioration

Muscle/ nerve impairment

Trauma

Medication

NMBAs
Corticosteroids
Aminoglycocides
Colistin

ICUAW/CIM

ICUAW

- Weakness in ICU patients that has no other aetiology than critical illness
- CIP/ CIM or combination
- Early onset
- Impairment of peripheral nerves, skeletal muscle
- Characterised by generalised weakness, atrophy
- Not homogenous disability or recovery — may be influenced by pre-existing nerve and muscle lesions and comorbidities
- May be influenced by mood, cognition, socio-economic status and caregiver status
- MRC score of < 48
- Pts with diagnosed ICUAW have significantly decreased MRC scores at hospital discharge, 3 and 6 months
- Lower FIM scores at 3 and 6 months

• SIRS and MODS predisposes to CIM/CIP
• 30-50% of critically ill patients – CIP, CIM or combination
• MOF or coma – 100% CIP or CIM prevalence
• Possible that CIP and CIM are not isolated events but integral part of process that leads to multi organ failure
• CIP and CIM may represent 2 independent injurious events that may or may not share common mediators
• Most likely represents a continuum of neurogenic and myogenic changes over time

• 2% and 3% loss of calf and thigh volume in first week bed rest
• 30% and 18% loss at 17 weeks of bed rest
• Overall lean muscle mass decrease of 12% in lower limbs in bed rest, 7% per week in critically ill
• Strength decrease of 9%, 17% and 30% in ankle DF, PF and knee extension (half of loss in first week)
• Return to work – 51% and 23% at 1 and 5 years
• 6MWD 66% and 76% of predicted at 1 and 5 years, despite normal/near normal pulmonary function

Kho et al 2013
• Decreased strength
• Longer ICU and hospital LOS
• Greater morbidity
• Greater mortality


• One year post ICU
  • Decreased rate of relative force development
  • Decreased endurance time

Poulsen et al 2013

• Loss of functional independence for 8 years following sepsis and critical illness

Iwashyna et al, Batt et al 2013

• High rate of new functional limitations in older patients
• Presence of ICUAW strongly associated with death
• Worse in-hospital morbidity
• Higher costs
• Worse 1-year mortality
• Distinguish between impaired muscle mass and muscle force
• True determinant of recovery may be extent to which structure and function are each restored
• Weakness not in isolation, but in combination with factors like proprioception, cognition

Herridge 2014 (editorial)
• Typically marked improvement in function first 6 months post-ICU, then plateau up to 1 year
• Variability in outcome depending on age, ICU LOS and comorbidities
• Study – older patients (53 vs 43 years) with average of 2 comorbid conditions – far worse outcomes – only 9% alive and without functional dependence

Batt et al 2013
Older persons

- Decreased physiologic reserve, chronic organ dysfunction, comorbidities prior to critical illness
- Decreased muscle mass, decreased force of contraction, slower rate of isometric contraction
- Lower baseline exercise tolerance
- Weakness exceeds what would be expected for muscle atrophy alone
- Especially due to decreased protein synthesis, increased proteolysis at baseline
- Blunted muscle anabolic response to exercise and feeding
- Reduced number of mitochondria

Batt et al 2013
• Older than 65 years - lose more lean tissue in 10 days than young people in 28 days
• Perform ADL at near maximum ability
• Rate of force development required for ADL may be issue
• Greatest impairments related to daily function
  • Carrying and lifting groceries
  • Climbing stairs
  • Kneeling
  • Walking moderate distances
• Suggest functional deficits due to muscle tissue rather than neural impairment

WHO Model of Health (ICF)

• Uses domains of body structures and body functions, functional activities and participation in life roles
• International classification of functioning, disability and health
• Acute phase - measures of body functions and structures dominate
• Intermediate phase - function measures begin to dominate
• Long term phase - measures of function, QOL
Three Phases of Rehabilitation

- Acute
- Intermediate
- Long term
Assessment of Critically Ill Patients

- Assessment should include QOL measure, activity measures and measures of structure and function (impairment)
- Assess ADL
- Assess upper and lower limb function as well as walk tests
- General functional tests often not translatable to ICU population
- PFIT and CPAx developed for critical care population
- MRC scale in ICU most reliable diagnostic technique to assess ICUAW

Dean 2008, Elliot et al 2011
Physical Function Assessment Tools

- Chelsea Critical Care Physical Assessment tool (CPAx)
- Functional Independence Measure (FIM)
- Functional Status Score for the Intensive Care Unit (FSS-ICU)
- i-MOVE tool
- ICU Mobility Scale (IMS)
- PFIT
- TUG
- Katz ADL
- Barthel Index
- DEMMI
Assistance (sit to stand)
Cadence (steps/minute)
Shoulder (flexion strength)
Knee (extension strength)
Day 1: Events
Patient admitted to hospital with shortness of breath and a two day history of difficulty breathing, coughing and pleuritic chest pain. Initially admitted to ward on CPAP but deteriorated and required sedation, intubation and transfer to ICU, diagnosed with Legionella pneumonia.

Observations:
CNS: fully sedated (-3)
CVS: T37.1; HR99, Bp104/55
Resp: ETT, SIMV, FiO₂ 0.6, PEEP 10, PS 15, sats 97%
ABG’s pH7.34 pCO₂ 6.9 pO₂ 9.5 HCO₃ 24.9

Physiotherapy: Chest management only, rehabilitation not appropriate
Impression: Sepsis, high oxygen requirement, in respiratory failure.

Day 2: Events
Developing multi-organ dysfunction syndrome (MODS) and now requiring vasopressors. Had a bronchoscopy; yellow sputum plugs cleared.

Observations:
CNS: fully sedated (-3)
CVS: Bp108/60 on 16 mcg/min nor-adrenaline. HR 110, T37.6
Resp: ETT, SIMV, FiO₂ 0.6, PEEP12, PS15, sats 97%
ABG’s pH7.25 pCO₂ 6.9 pO₂ 10 HCO₃ 21.3 BXS -1.7
Renal function deteriorating: Creatinine 164, u/o 7/10/18/18 mins/hour
Pharmacologically paralysed for the bronchoscopy

Physiotherapy: Chest management only, rehabilitation not appropriate
Impression: Clinically deteriorating, MODS

Day 4: Events
Continued MODS. Still ventilated via ETT and sedated. No longer paralysed. Dialysed due to renal failure. Legionella found in urine.

Observations:
CNS: fully sedated (-3)
CVS: 100/50 on 16mcg/min nor-adrenaline. T38.2, HR100.
Resp: ETT, SIMV, FiO₂ 0.6, PEEP12, PS Sats 94%
ABG’s: pH7.25, pCO₂ 5.5, pO₂ 10.6, HCO₃ 18.2
BXS -8.6
Bloods: CRP458, WCC 5.8, Platelets 613.

Physiotherapy: Chest management only, rehabilitation not appropriate
Impression: MODS.
Choice of Measure

• Changes over time
• On acute ward might be ROM
• In community function in ADL, which is confounded by pain, work performance and demands of environment
• Need to understand patient expectations

Szu-Yen Lin et al 2013
Rehabilitation

• WHO 2011 definition:
  “Set of measures that assist individuals who experience, or are likely to experience, disability to achieve and maintain optimal functioning in interaction with their environment”

• “Occurs for a specific period of time, and can be needed from the acute or initial phase immediately following recognition of a health condition”

Kho et al 2012
Exercise intervention improved participants’ sense of well-being, achievement and desire to progress.

Participants feel fitter and able to do more with increasing activity levels.

Impact extends beyond physical effects, improving motivation and social inclusion.
Treatment of ICU patients

- European Respiratory Society and European Society of Intensive Care Medicine Task Force on the effectiveness of physiotherapy for acute and chronic critically ill patients
- Evidence-based targets for physiotherapy:
  - Deconditioning
  - Muscle weakness
  - Joint stiffness

- Evidence-based clinical management algorithms for the early physical activity and mobilization of critically ill patients

Gosselink et al 2011
Hanekom et al 2011, Stiller 2013
The Role of the Physiotherapist in the Acute Care Setting

- Expertise in mobility and movement dysfunction
- Use specialised knowledge to create care plan, inform prognosis
- Analyze movement gained
- Concerned with quality, efficiency and functionality of movement, not just ability to perform it
- Continual dynamic assessment = clinical reasoning, ability to adapt treatment according to changing needs and data
- Discharge planning to next, appropriate level of care
- Patient and care-giver education

Masley et al 2011
Study findings - Schweikert

- Randomized to early mobilization or therapy as ordered
- Muscle strength improvement
- Faster return to function (59% vs 35%)
- Decreased weaning time, MV days
- Decrease in delirium days
- ICU-AW in 31% intervention vs 49% controls
- However, outcomes did not translate into difference in ICU or hospital LOS

Schweikert et al 2009
• Study on long-term MV patients - early mobilization and ambulation
• BD mobilisation with multidisciplinary team
• At ICU discharge 69% of patients ambulated >100 feet
• Higher level of activity achieved with same resources as other ICU’s at that facility
• Results irrespective of age, MOF, ventilatory needs

Bailey 2007
Kho et al

- Systematic review of 10 trials on physio:
  - Small positive effect on muscle strength
  - Significant moderate effect on respiratory muscle strength
  - Small significant effect on physical function (Barthel Index)
  - Small significant effect on MV days
  - Small significant effect on HRQOL
  - Small reduction in ICU and hospital LOS
  - No effect on hospital mortality

Kho et al 2013
Kyambu et al

- Systematic review of 10 RCTs and 5 reviews
- Significant positive effect on
  - QOL
  - Physical function
  - Peripheral muscle strength
  - Respiratory muscle strength
  - LOS
  - Ventilator-free days
- No effect on mortality

Kyambu et al 2013
• Systematic review
• Only effective intervention to improve long-term physical functioning is exercise/physiotherapy
• May obtain better outcomes if intervention is started earlier

Calvo-Ayala et al 2013
Current Trends

- Severely ill MV patients - limited early activity
- Activity beyond bed rest on only 11% of ICU days
- ICU survivors inactive 2 months post-discharge
- Inactive 90% of the time
- Only walking 3% of the time
- 37% spent 30mins/day in locomotion
- Lower level activities carried out more often
- Most common form of active rehab was active-assisted exercise and SOEOB
- Least common activity was walking
- Median time to SOEOB – 10 days

Denehy et al 2012, Knott et al 2015
Point Prevalence Study Australia and New Zealand

- 18% of patients walked
- 23% of pts in ICU for ≥7 days - not SOEOB or walked
- 30% of patients with \(O_2\) therapy walked

Berney et al 2013

- 24% of patients mobilised out of bed
- 8% on MV were mobilised
- 4% stood, marched or walked

Nydahl et al 2014
Effects of Early Exercise

- Regular exercise decreases CRP, insulin sensitivity, IL-6 – inhibits inflammatory cytokines eg TNF
- Decreases oxidative stress and inflammation
- Improved orientation, cognitive function, decreased delirium
- Might decrease LOS, MV time
- Passive stretching preserves architecture of muscle fibers
- Moderate resistance exercise counteracts decrease in muscle protein synthesis

• Increases in strength by hospital discharge
• Functional ability improved
  • Time to mobility milestones reached faster
  • Ambulation distance further
  • FIM and FSS-ICU improved
• QOL and symptoms
  • Dyspnea reduced
  • SF-36 improved
Exercise Prescription

• Dedicated physical activity and movement program
• Encompasses full spectrum of physical activity from limb movement to walking
• Components
  • focus on increasing muscle strength
  • treating deconditioning
  • maintaining muscle mass and function
• Limb muscle training using active and passive movement and progressive mobilisation plan
• Support of psychosocial needs and reducing anxiety, depression
• Programs aimed at progressive activity and walking
• Based on functional capability and ability to tolerate activity
• E.g Perme, Morris, Leuven University
• Phases with guidelines:
  positioning  exercise type  transfers
  gait retraining  education
• Duration, frequency
• MDT effort
  Morris 2007, Perme 2009
# Perme Program

<table>
<thead>
<tr>
<th>Phase 1</th>
<th>Phase 2</th>
<th>Phase 3</th>
<th>Phase 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acute – profound weakness</td>
<td>Acute/ subacute-weak, limited exercise tolerance</td>
<td>Acute/ subacute – increased activity levels tolerated</td>
<td>Subacute – toward functional independence</td>
</tr>
<tr>
<td>Sit over edge</td>
<td>Initiate transfer training</td>
<td>Independent transfer</td>
<td>Transfer and walking independence</td>
</tr>
<tr>
<td>Initiate standing with aid</td>
<td>Walking re-education</td>
<td>Progressive walking</td>
<td>Promote independence with exercise and mobility program</td>
</tr>
<tr>
<td>Prewalking activities</td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>
## ‘Start to move’ protocol Leuven: step-up approach for progressive mobilisation and physical activity program

<table>
<thead>
<tr>
<th>LEVEL 0</th>
<th>LEVEL 1</th>
<th>LEVEL 2</th>
<th>LEVEL 3</th>
<th>LEVEL 4</th>
<th>LEVEL 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>NO COOPERATION</td>
<td>NO/LOW COOPERATION</td>
<td>MODERATE COOPERATION</td>
<td>CLOSE TO FULL COOPERATION</td>
<td>FULL COOPERATION</td>
<td>FULL COOPERATION</td>
</tr>
<tr>
<td>S5Q1 = 0</td>
<td>S5Q1 &lt; 3</td>
<td>S5Q1 = 3</td>
<td>S5Q1 = 4/5</td>
<td>S5Q1 = 5</td>
<td>S5Q1 = 5</td>
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<tr>
<td>FAILS BASIC ASSESSMENT²</td>
<td>PASSES BASIC ASSESSMENT²</td>
<td>PASSES BASIC ASSESSMENT²</td>
<td>PASSES BASIC ASSESSMENT³</td>
<td>PASSES BASIC ASSESSMENT³</td>
<td>PASSES BASIC ASSESSMENT³</td>
</tr>
<tr>
<td>BASIC ASSESSMENT =</td>
<td>Neurological or surgical or trauma condition does not allow transfer to chair</td>
<td>Obesity or neurological or surgical or trauma condition does not allow active transfer to chair (even if MRCsum ≥ 36)</td>
<td>MRCsum ≥ 48</td>
<td>MRCsum ≥ 48</td>
<td>MRCsum ≥ 48</td>
</tr>
<tr>
<td>Cardiorespiratory unstable:</td>
<td></td>
<td></td>
<td>BBS Sit to stand = 0</td>
<td>BBS Sit to stand = 0</td>
<td>BBS Sit to stand = 0</td>
</tr>
<tr>
<td>MAP &lt; 60mmHg or</td>
<td></td>
<td></td>
<td>BBS Standing = 0</td>
<td>BBS Standing = 0</td>
<td>BBS Standing = 0</td>
</tr>
<tr>
<td>FiO₂ &gt; 60% or</td>
<td></td>
<td></td>
<td>BBS Sitting ≥ 1</td>
<td>BBS Sitting ≥ 1</td>
<td>BBS Sitting ≥ 1</td>
</tr>
<tr>
<td>PaO₂/FiO₂ &lt; 200 or</td>
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<tr>
<td>RR &gt; 30 bpm</td>
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<tr>
<td>Neurologically unstable</td>
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<tr>
<td>Acute surgery</td>
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<tr>
<td>Temp &gt; 40°C</td>
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</tr>
<tr>
<td>BODY POSITIONING¹</td>
<td>2hr turning</td>
<td>Splinting</td>
<td>Upright sitting position in bed</td>
<td>Sitting out of bed</td>
<td>Active transfer bed to chair</td>
</tr>
<tr>
<td>Fowler’s position</td>
<td></td>
<td></td>
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<td></td>
<td>Sitting out of bed</td>
</tr>
<tr>
<td>Splinting</td>
<td></td>
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<td></td>
<td>Standing with assist (≤2 persons)</td>
</tr>
<tr>
<td>PHYSIOTHERAPY²</td>
<td>Passive range of motion</td>
<td>Passive transfer bed to chair</td>
<td>Standing with assist (≤2 persons)</td>
<td>Active transfer bed to chair</td>
<td></td>
</tr>
<tr>
<td>Passive bed cycling</td>
<td></td>
<td></td>
<td></td>
<td>Sitting out of bed</td>
<td></td>
</tr>
<tr>
<td>NMES</td>
<td></td>
<td></td>
<td></td>
<td>Standing</td>
<td></td>
</tr>
<tr>
<td>BODY POSITIONING¹</td>
<td>2hr turning</td>
<td>Passive transfer bed to chair</td>
<td>Active transfer bed to chair</td>
<td>Active transfer bed to chair</td>
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</tr>
<tr>
<td>Splinting</td>
<td>Sitting out of bed</td>
<td>Sitting out of bed</td>
<td>Sitting out of bed</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PHYSIOTHERAPY²</td>
<td>Passive/Active range of motion</td>
<td>Resistance training arms and legs</td>
<td>Resistance training arms and legs</td>
<td>Resistance training arms and legs</td>
<td></td>
</tr>
<tr>
<td>Resistance training arms and legs</td>
<td>Active leg and/or arm cycling in bed or chair</td>
<td>Active leg and/or arm cycling in bed or chair</td>
<td>Active leg and/or arm cycling in bed or chair</td>
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</tr>
<tr>
<td>Passive/Active leg and/or cycling in bed or chair</td>
<td>NMES</td>
<td>NMES</td>
<td>NMES</td>
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<tr>
<td>NMES</td>
<td>ADL</td>
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</table>

**Notes:**
- S5Q1: Sickness Impact Profile
- MRCsum: Medical Research Council sum score
- BBS: Berg Balance Scale
- NMES: Non-Motor Exercise Stimulation
- ADL: Activities of Daily Living

¹ BODY POSITIONING: 2hr turning
² PHYSIOTHERAPY: Passive/Active range of motion
³ Physiotherapy with assist (≤2 persons)
⁴ Physiotherapy with assist (≤1 persons)
'Start to move' - protocol Leuven: step-up approach of progressive mobilisation and physical activity program

1) SSQ: response to 5 standardized questions for cooperation:
   Open and close your eyes
   Look at me
   Open your mouth and stick out your tongue
   Shake yes and no (nod your head)
   I will count to 5, frown your eyebrows afterwards

2: FAILS = at least 1 risk factor present
3: if basic assessment failed, decrease to level 0
4: safety: each activity should be deferred if severe adverse events (cv., resp. and subject. intolerance) occur during the intervention

MRC (Medical Research Council) muscle strength sum scale(0-60)
BBS: Berg Balance Score
SITTING TO STANDING
4 able to stand without using hands and stabilize independently
3 able to stand independently using hands

2 able to stand using hands after several tries
1 needs minimal aid to stand or stabilize
0 needs moderate or maximal assist to stand

STANDING UNSUPPORTED
4 able to stand safely for 2 minutes
3 able to stand 2 minutes with supervision
2 able to stand 30 seconds unsupported
1 needs several tries to stand 30 seconds unsupported
0 unable to stand 30 seconds unsupported

SITTING WITH BACK UNSUPPORTED BUT FEET SUPPORTED ON FLOOR OR ON A STOOL
4 able to sit safely and securely for 2 minutes
3 able to sit 2 minutes under supervision
2 able to able to sit 30 seconds
1 able to sit 10 seconds
0 unable to sit without support 10 seconds
• Early activity **MUST** happen
• Must happen safely
• Push for highest level of activity
• Physical rehabilitation starting only after hospital discharge does not improve patient-centred outcomes
Factors that Hinder Mobilisation

- Equipment and devices
- Sleep deprivation
- Use of sedation
- Inadequate nutrition

- ICU culture of preferred immobility
- No clear MDT approach – fragmented care

Hopkins and Spuhler 2009, Perme 2009
Feasibility and safety

- Many studies
- Early mobilisation safe and feasible
- Adverse incidents < 1% with early mobility, including walking

Up and about with an open abdomen
Activities

- Passive ROM exercise
- Active-assisted exercise
- Active exercise
- Resisted exercise
- Bed mobility
- Trunk control
- Sitting over edge of the bed
- Transfers
- Functional training
- Pre-gait exercises
- Walking, with and without aids
- Bedcycling
- IMT
- Velocity-orientated exercise – especially older persons
Weakness or fatigue of the diaphragm and accessory muscles - major cause of failure to wean from MV

Prolonged MV – decrease in respiratory muscle endurance

Some evidence that MV may adversely affect diaphragmatic structure and function - ventilator-induced diaphragmatic dysfunction

Changes in myofibre length and rapid atrophy

Studies confirm profound atrophy in diaphragm muscle fibres

**Inspiratory Muscle Training (IMT)**

- High-quality limited evidence concerning the effectiveness of IMT for ICU patients
- Loads diaphragm and accessory inspiratory muscles
- Aims to increase strength and endurance
- Patients on MV –
  - application of devices that impose resistive loads
  - adjustment of ventilator sensitivity settings - patient needs to generate greater negative intrathoracic pressures to initiate inspiratory flow
- Inspiratory muscles respond to training like other skeletal muscles in terms of the principles of overload, specificity, and reversibility

• Significant improvement in MIP
• Favourable trends for weaning duration, weaning success and survival
• Numerous case reports and case series confirming data
• Unclear if increase in MIP translates into benefit in weaning, survival
  Moodie et al 2011, Patsaki et al 2013
Peiris et al

- Multicenter RCT
- Additional 1 day of therapy (physio and OT) – 6 vs 5 days/week
- Higher FIM on discharge at 6 months but not 1 year
- HRQOL and functional independence better at discharge and 6 months but not 1 year
- Decreased LOS
- Reduced time for fx decline – shorter break between sessions
- More physical activity during weekends

Peiris et al 2013
PIX-study

• 8-week supervised, in-hospital exercise program
• Positive biopsychosocial effects of exercise programme
  • Source of motivation, routine
  • Reduced boredom, isolation, inactivity
  • Enhanced psychological well-being
  • Emotional support
  • Enhanced level of physical fitness, accessible exercise
• Suggest –
  • Group exercise enhances motivation
  • Psychological benefit – see other people who are the same as you

Walker et al 2015
Substantial improvement in early fitness (week 9)
Expedites return to ADL, “natural” recovery process
Not sustained following completion of 8 week exercise
If exercise not sustained, same long-term outcome as non-intervention
Exercise improved sense of well-being, achievement and desire to progress
Participants felt fitter and able to do more with increasing activity levels
Impact extended beyond physical effects

Walker et al 2015
Quality of Life

• WHO definition
  “an individual’s perception of their position in life in the context of the culture and value systems in which they live, and in relation to their goals, expectations, standards and concerns”

• Influenced by physical health, psychological state, level of independence, social relationships, personal beliefs and relationships to significant features in their environment

Grisbrook et al 2012
Quality of Life - Statistics

• 1 year post event
  • 50% unemployed
  • 100% report poor function due to fatigue, wasting and weakness
  • Reduced rate of force development and muscular endurance
• Reduced SMWD test even 5 years later in ARDS
• Worse SF-36
• Impairments often in domains related to physical function
• Psychological impairments

Conclusion

- Episode of critical illness as continuum –
  - acute clinical deterioration
  - rehabilitation in ICU
  - rehabilitation after ICU
  - hospital discharge

Elliot et al 2011

- Foster culture of commitment to early activity
- Patient-centered outcomes
- Focus on long-term outcomes
Surviving critical illness is just the beginning....

Batt et al 2013