Employing Resistance Training as a Therapeutic Intervention for Cancer Survivors

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Objectives

2. Describe the adaptations of the cancer survivor to a resistance training program.
3. Introduce clinicians to the resistance training programs recommendations contained in currently available guidelines and to training protocols that have been reported in the literature.

4. Describe techniques that can be used to evaluate muscle strength and power.
5. Introduce clinicians to new resistance training protocol’s that might be useful in treating cancer survivors.
6. Utilize case studies to demonstrate the clinical application of material presented in this session.

What is Resistance Exercise Training (RET)

• “Strength Training” or “Strengthening”
• “Resistance training is a form of physical activity that is designed to improve muscular fitness by exercising a muscle or a muscle group against external resistance.”

• Am. College of Sports Medicine (ACSM)

Goals of RET in The Clinic

• Increased strength
• Improved physical functional capacity
• Alter body composition
• Improve quality of life
• Increase power/endurance
• Reduce impact of comorbidities
• Improve cognition

Goal: Increase the force and the power that a muscle can generate
Mechanisms for Increasing Strength

- Increased capacity to generate energy
- Improved Ca\(^{2+}\) handling
- Increased amount of sarcomeric proteins
- Increase in muscle fiber size
- Increased lean body mass or muscle mass and area
- Fiber type changes
- Increased muscle protein synthesis

What is Cancer?

- "Uncontrolled growth"

Skeletal Muscle Dysfunction in Cancer Survivors

- Have significantly lower muscle strength than age matched healthy controls
  - ↓ 1 RM
- Have less muscle mass than age matched healthy controls
  - ↓ Lean body mass and area
  - ↓ fat free mass

Cancer Continuum

- Reduced mitochondrial function
- Upregulation of muscle degradation pathways
- Significant reductions in muscle fiber size
- Fiber type changes - loss of Type IIX
- Reduction in numbers of satellite cells

Skeletal Muscle Dysfunction and Cancer Treatment

- Surgery
  - Loss and damage to muscles
  - Compromised innervation

- Radiation
  - Damage to satellite cells
  - Fibrosis
  - Altered cellular metabolism

- Chemotherapy
  - Oxidative stress/impaired mitochondrial function
  - Damage to satellite cells

Skeletal Muscle Dysfunction 2^0 to Comorbid Conditions

- Sarcopenia:
- Frailty
- Cachexia
- Inactivity
- Malnutrition
- Cellular changes consistent with reduced function

Skeletal Muscle Dysfunction in Cancer Survivors: Sarcopenia

- Sarcopenia: the loss of skeletal muscle mass and strength that occurs with advancing age

Skeletal Muscle Dysfunction in Cancer Survivors: Frailty

- Frailty: A medical syndrome that is characterized by diminished strength, endurance, and reduced physiologic function that increases an individual’s vulnerability for developing increased dependency and/or death.

- "Chronological age does not equal physiologic age"

Age and Ageing 2014;43: 8–9

RET as a counter measure

- Unclear
- Require a multimodal approach i.e. combine exercise with appropriate nutritional support

Skeletal Muscle Dysfunction in Cancer Survivors: **Frailty Phenotype**

- Unintentional weight loss
  - > 10 pounds in prior year
  - > 5% of body weight in prior year
- Weakness
  - Grip strength in the lowest 20% at baseline
- Poor endurance/fatigue
- Self report

Skeletal Muscle Dysfunction in Cancer Survivors: **Frailty in Cancer Survivors**

- More than half of older cancer patients have pre-frailty (2 of the 5 phenotypes) or frailty (3 or more of the frailty phenotypes) and these patients are at increased risk of chemotherapy intolerance, postoperative complications and mortality

### Study Results

<table>
<thead>
<tr>
<th>Study or subgroup</th>
<th>log (Hazard ratio)</th>
<th>Frailty or pre-frailty</th>
<th>Total</th>
<th>Frail, Random, 95% CI</th>
<th>Hazard ratio (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.1 30 day post-operative mortality (frailty)</td>
<td>0.79888</td>
<td>0.79888</td>
<td>0.79888</td>
<td>0.6049</td>
<td>0.4322</td>
</tr>
<tr>
<td>1.2 30 day post-operative mortality (pre-frailty)</td>
<td>0.79888</td>
<td>0.79888</td>
<td>0.79888</td>
<td>0.6049</td>
<td>0.4322</td>
</tr>
<tr>
<td>1.3 6 month mortality (frailty)</td>
<td>0.79888</td>
<td>0.79888</td>
<td>0.79888</td>
<td>0.6049</td>
<td>0.4322</td>
</tr>
<tr>
<td>1.4 6 month mortality (pre-frailty)</td>
<td>0.79888</td>
<td>0.79888</td>
<td>0.79888</td>
<td>0.6049</td>
<td>0.4322</td>
</tr>
<tr>
<td>1.5 5 year mortality (frailty)</td>
<td>0.79888</td>
<td>0.79888</td>
<td>0.79888</td>
<td>0.6049</td>
<td>0.4322</td>
</tr>
<tr>
<td>1.6 5 year mortality (pre-frailty)</td>
<td>0.79888</td>
<td>0.79888</td>
<td>0.79888</td>
<td>0.6049</td>
<td>0.4322</td>
</tr>
</tbody>
</table>


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Skeletal Muscle Dysfunction in Cancer Survivors: **Inactivity**

Skeletal Muscle Dysfunction in Cancer Survivors: **Inactivity**

- Of 157 patients in a primary care clinic
  - 10% received general advice to decrease sitting time
  - 53% received general physical activity counselling
  - 0% received a treatment plan for reducing sitting time


Skeletal Muscle Dysfunction in Cancer Survivors: **Cachexia**

- Characterized by severe decline in muscle mass
- Results from disease processes, systemic inflammation, malnutrition and activation of muscle degradation pathways
- Associated with advance disease
- It is not the equivalent of anorexia

Skeletal Muscle Dysfunction in Cancer Survivors: **Cachexia Symptoms**

- Unintentional weight loss > 5% of body weight
- BMI < 20 for those < 65 YOA & < 22 for those > 65
- Having less than 10 percent body fat
- An albumin level of less than 35 grams per liter (Reference Range: 35-55 g/liter)
- There is insufficient evidence to determine the safety and effectiveness of exercise for patients with cancer cachexia.


Intermediate Summary

- Cancer survivors are at risk for increased loss of muscle mass relative to age-matched healthy controls:
  - Age
  - Disease/treatment affects
  - Comorbidities
  - Inactivity

Is Participation in a RET Program Safe?

- “The results of completed studies support the safety of upper-body exercise among breast cancer survivors with and at risk for lymphedema.”
- “Training should start supervised, at a low dose, increase according to symptom response, and is likely to increase maximal and functional capacity of the affected arm.”
- Benefits in terms of conditioning outweigh risk of developing or exacerbating lymphedema

Is Participation in a RET Program Safe?

- 100 subjects; RCT; 2 subjects withdrew because of MS injuries, both conditions were pre-existing
- 28 subjects, RCT, 3 subjects withdrew because of MS injuries
  - Nilsen et al. Acta Oncol. (Stockh. Swed.) 2015; 54; 1805
- 10 subjects with metastatic prostate disease; RCT; 0 adverse effects during exercise sessions, withdrawals from study 5- disease progression, 3, bone pain, 1, fall

Is Participation in a RET Program Efficacious?


Is Participation in a RET Program Efficacious?


Exercises Guidelines

- “Adults should do muscle strengthening activities that are moderate or high intensity and involve all major muscle groups on 2 or more days a week”
- “Adults with disabilities should also do muscle-strengthening activities of moderate or high intensity that involve all major muscle groups on 2 or more days a week”

Exercise Guidelines

- “Older adults with chronic conditions should understand whether and how their conditions affect their ability to do regular physical activity safely”
- “Avoid inactivity”

Exercise Guidelines

American College of Sports Medicine Roundtable on Exercise Guidelines for Cancer Survivors

Expert Panel
Kathryn H. Schmitz, PhD, MPH, FACSM
Kerry S. Courneya, PhD
Charles Matthews, PhD, FACSM
Wendy Demark-Wahnefried, PhD
David A. Galvan, PhD
Bernadine M. Finn, PhD
Melissa L. Infante, PhD, FACSM
Kathleen Y. Weller, ND, FACSM
Rosanne J. Sigal, MD, FACP
Alejandro Luria, MD, PhD
Carole M. Schneider, PhD, FACSM
Vivian F. von Gruenigen, MD
Anna L. Schwartz, PhD, FAAN


Exercise Guidelines

• Breast Cancer
  • Start with a very low resistance
  • Progress slowly
  • Monitor for arm/shoulder symptoms
  • Modify exercise program per symptoms
  • Wear compression garment while performing exercise
  • Little risk for exacerbating lymphedema

Exercise Guidelines

• Prostate Cancer
  • Recommendations are the same as age-appropriate PAG
  • Add Pelvic floor exercises for those who undergo radical prostatectomy
  • Be aware of fracture risk

Exercise Guidelines

• Colon Cancer
  • Recommendations are the same as age-appropriate PAG.
  • Presence of a stoma:
    • Start with low resistance
    • Progress slowly
    • Stoma management

Exercise Guidelines: Fracture Risk

• Assess for fracture risk in:
  • Prostate cancer survivors-hormone therapy
  • Breast cancer survivors-AI’s
  • Metastatic disease
  • Advanced disease

• Assessment tools
  • World Health Organization Fracture Risk Assessment Tool (FRAX)
  • DXA scan-Bone Mineral Density

• ACSM Guidelines recommends a preexercise evaluation for fracture risk in survivors on hormone therapy
• World Health Organization Fracture Risk Assessment Tool (FRAX)
• NCCN and Medicare recommend treatment for those with a 10-year hip fracture risk of at least 3% or a 10-year major osteoporosis fracture risk of at least 20%.
Fracture Risk

Exercise Guidelines: Fracture Risk

- **Other Comments**
  - Medicare covers DEXA scans
  - Risk factor includes: age, wt. under 70 kg, prior non-traumatic fracture
  - Prostate cancer survivors are assumed to have secondary osteosarcoma
  - Multiple myeloma survivors should be treated as if they were osteoporotic
  - "No fracture risk level has been defined as indicating that exercise is unsafe". ACSM Guidelines

Risk factors

https://www.sheffield.ac.uk/FRAX/tool.jsp

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Things to Think About

- **Quantify exercise dose**
  - Composite physical activity

- **Selection biased in exercise studies**
  - The healthiest tend to complete studies

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Table 10.3 Precautions to Take in Exercise Prescription for Cancer Patients

<table>
<thead>
<tr>
<th>Precaution</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bone density</td>
<td>No bone density scan prior to exercise prescription.</td>
</tr>
<tr>
<td>Severe peripheral edema</td>
<td>No peripheral edema due to bone metastases.</td>
</tr>
<tr>
<td>Severe peripheral neuropathy</td>
<td>No peripheral neuropathy.</td>
</tr>
<tr>
<td>Severe arterial insufficiency</td>
<td>No arterial insufficiency.</td>
</tr>
<tr>
<td>Medications</td>
<td>No medications that may affect exercise performance.</td>
</tr>
<tr>
<td>Exercise intensity</td>
<td>No exercise intensity that may affect exercise performance.</td>
</tr>
<tr>
<td>Time between sets</td>
<td>No time between sets that may affect exercise performance.</td>
</tr>
<tr>
<td>Number of sets</td>
<td>No number of sets that may affect exercise performance.</td>
</tr>
<tr>
<td>Duration of exercise session</td>
<td>No duration of exercise session that may affect exercise performance.</td>
</tr>
<tr>
<td>Training intensity</td>
<td>No training intensity that may affect exercise performance.</td>
</tr>
</tbody>
</table>

Things to Think About

- **Documentation**
  - Generally deficient in describing components of the exercise prescription, progression of the program and adherence to the program

- **Winters-Stone, 2014**

Training period (duration of Tx plan)

- Frequency
- # sets
- Time between sets
- Time under tension
- Time between reps
- Training intensity (RPE)

Borde et al. Sports Med. 2015;45:3693
FITT PRINCIPLE

• FITT: Frequency, Intensity, Time (duration), Type

Threshold model:

• Achieve sufficient physiological challenge to bring about adaptive changes/training, effects, reconditioning

• Combining these elements (FITT) we can prescribe an adequate volume of exercise to bring about an adaptive response (reconditioning)

Resistance Exercise Prescription in the Cancer Patient

• American College of Sports Medicine (ACSM)
  • 1-3 times per week
  • 50-80% 1RM or 6-12RM
  • 1-4 sets, 6-10 exercises

• Exercise and Sports Science Australia
  • 2-3 days per week
  • 60-70% 1RM
  • 1-3 sets of 8-12 repetitions

Periodization

• “The division of an annual training plan into smaller training phases, making it easier to plan, monitor, and adjust a training plan in an effort to optimize key outcomes”
Non-Linear Periodization

- Weekly Undulating Periodization (WUP)
  - Altering the number of repetitions & training focus each week.
- Daily Undulating Periodization (DUP)
  - Changing the number of repetitions & intensity each day or training session


Daily Undulating Periodization (DUP)

In healthy individuals

- Improved bench press 1RM
- Improved squat 1RM
- Upward trend for leg press 1RM

Exercise Prescription Principles

- Individualization
- Specificity
- Progressive Overload
- Rest/Recovery

Linear Periodization

- Weeks 1-3
  - 3 x 10 (75% 1RM)
- Weeks 4-6
  - 3 x 8 (80% 1RM)
- Weeks 7-9
  - 4 x 6 (85% 1RM)

Daily Undulating Periodization

- Monday
  - 3 x 10 (75% 1RM)
- Wednesday
  - 3 x 8 (80% 1RM)
- Friday
  - 4 x 6 (85% 1RM)

Autoregulation

- Adjust intra-training load
- Progress load from week to week
- Select a daily set and repetition scheme

Leads to:

- Prevent Injury
- Increase adherence
- Increase quality of life

Blood Flow Restriction

- Pneumatic cuff that provides venous occlusion to the distal aspect of the limb.
- Creates an anaerobic environment at which the lower oxygen tension level allows the body to recruit muscle fibers that are normally reserved for more strenuous exercise.
- Upregulation of the muscle hypertrophy-signaling cascade
Blood Flow Restriction

- Diminished atrophy & loss of strength
- Increased strength with only 30% of normal loads
- Increased hypertrophy with only 30% normal loads
- Improved muscle endurance in 1/3 the time


Establishing A Baseline

- 1 Rep Max
  - The maximum weight that can be lifted correctly for one time
  - Safe and reliable measurement tool
- Multiple Rep Max
  - Some see this as a "safer" option
  - Still provides a baseline for choosing intensity of exercise

1 Rep Max

- How do we determine 1 rep max?
  - Manually
  - Oddvar Holten Diagram
- The average adult can do 10 reps at 75% of their 1RM before fatiguing

Oddvar Holten Diagram

![](image)

<table>
<thead>
<tr>
<th>%1RM</th>
<th>Number of repetitions allowed</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
<td>1</td>
</tr>
<tr>
<td>95</td>
<td>2</td>
</tr>
<tr>
<td>90</td>
<td>3</td>
</tr>
<tr>
<td>87</td>
<td>4</td>
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<td>85</td>
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<td>80</td>
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<td>67</td>
<td>10</td>
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<td>65</td>
<td>11</td>
</tr>
<tr>
<td>60</td>
<td>12</td>
</tr>
<tr>
<td>55</td>
<td>15</td>
</tr>
</tbody>
</table>

Essentials of Strength Training and Conditioning
1 Rep Max vs. Multi Rep Max

Rating of Perceived Exertion

<table>
<thead>
<tr>
<th>Rating</th>
<th>Perceived Exertion</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>No exertion</td>
</tr>
<tr>
<td>7</td>
<td>Extremely light</td>
</tr>
<tr>
<td>9</td>
<td>Very light</td>
</tr>
<tr>
<td>10</td>
<td>Light</td>
</tr>
<tr>
<td>11</td>
<td>Light</td>
</tr>
<tr>
<td>13</td>
<td>Somewhat hard</td>
</tr>
<tr>
<td>14</td>
<td>Hard</td>
</tr>
<tr>
<td>15</td>
<td>Hard</td>
</tr>
<tr>
<td>16</td>
<td>Very hard</td>
</tr>
<tr>
<td>17</td>
<td>Extremely hard</td>
</tr>
<tr>
<td>20</td>
<td>Maximal exertion</td>
</tr>
</tbody>
</table>

RPE & Repetitions in Reserve

- During or upon completion of a set the patient records an REP which corresponds to an RIR
  - 10 RPE = 0 RIR
  - 9 RPE = 1 RIR
  - 8 RPE = 2 RIR
  - And so on....

STRENGTH: METHODS OF ASSESSMENTS

- Hand held dynamometer
- Isokinetic machines

Summary

- Cancer survivors have less than optimal strength for a number of reasons.
- This adds to the symptom burden experienced by survivors.
- Participation in RET is both safe and efficacious.
- Collectively, participation in a RET program should be a part of a comprehensive physical therapy treatment plan for a cancer survivor.


Thank you for the privilege of the podium