ADULT SURVIVORS OF CHILDHOOD CANCER

Emily S. Tonorezos, MD MPH
Adult Long-Term Follow-Up Program

Outline

- Background
- Epidemiology of childhood cancer
- Model for risk-based care
- Case presentations
- The role of diet and physical activity
- Contemporary treatment
- Conclusions and future directions
Over 325,000 childhood cancer survivors are currently living in the United States.

Approximately 12,060 new cancer cases occurred among children 0 to 14 years of age during the year 2012.
Long-Term Mortality

Mertens A C et al. JCO 2001;19:3163-3172

Secondary Malignant Neoplasms

Cancer risks by radiation dose

Breast cancer
Meningioma (open boxes)
Glioma (closed boxes)
Thyroid cancer

Potential Late Effects

Cumulative incidence of chronic physical health conditions among 10,397 young adult survivors of childhood cancer

Oeffinger NEJM 2006;355:1572-82.
Potential Late Effects

Figure 3. Cumulative mortality due to recurrence of cancer, second malignancy, cardiac disease, pulmonary disease, external causes, and all other causes.


Radiation dose and CVD

Potential Late Effects

Care of the Cancer Survivor

Risk-based cancer related care (17.8%)
No medical care (11.2%)
General cancer related care (13.7%)
General non-cancer related care (57.3%)

Surveillance Testing by Level of Follow-Up Care

Model of Risk-Based Care

Kevin Oeffinger, MD
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Joanne Candela, NP
Roseann Tucci, NP
Beth Whittam, NP
Amelia DeRosa, RN
Jennifer Ford, PhD
Barbara Golby, LCSW
Marissa Healey
Model of Risk-Based Care

- Prior to visit, the medical chart is reviewed and treatment summary with screening recommendations is prepared.
- Day of visit, patient may have:
  - Visit with MD and NP
  - Blood work
  - ECHO, EKG, DXA, PFT’s, or other imaging
  - Referrals

Survivorship Care Plan

<table>
<thead>
<tr>
<th>Name:</th>
<th>Date of Birth:</th>
</tr>
</thead>
</table>

**Cancer Diagnosis:**

- Treatment center: Memorial Sloan-Kettering Cancer Center
- Age at diagnosis:
- Date of completion of therapy:

**Surgery**

<table>
<thead>
<tr>
<th>Date</th>
<th>Procedure</th>
</tr>
</thead>
</table>

**Radiation Therapy**

<table>
<thead>
<tr>
<th>Date start</th>
<th>Date Stop</th>
<th>Field</th>
<th>Dose (cGy)</th>
</tr>
</thead>
</table>

**Chemotherapy:**

<table>
<thead>
<tr>
<th>Drug Name</th>
<th>Dose (units or mg/m²)</th>
</tr>
</thead>
</table>

**Potential Late Effects**

- Cardiac
- Lung
- Thyroid
- Fertility
- Musculoskeletal
- Osteopenia/Osteoporosis
- Infection
- Second cancers (infrequent)

**Screening Recommendations**

- Complete physical exam every year
- EKG and Echocardiogram annually
- Breast MR/Mammogram yearly
- Cervical US beginning...
- DXA
- Pulmonary function tests
- Colonoscopy every 5 yrs starting at age 35
- Annual blood work: CBC, comprehensive panel, TSH, Vit D 25-OH, fasting lipids, insulin, urinalysis
- See MD for temp over 101°F
Clinical example

- Christy is a 38 yo woman treated for Hodgkin Lymphoma (Stage IV) at age 15 with:
  - 2100 cGy to mantle field (only partially shielded lungs) and 2100 cGy to para-aortics
  - Doxorubicin (“Adriamycin”) 300 mg/m²
  - Bleomycin, Vinblasticine
  - Dacarbazaine
  - Splenectomy
Mantle Radiation

Mantle  Para-aortic  Inverted "Y"  Total nodal
Clinical example: Mantle Radiation

- Body parts that get radiation:
  - Breasts
  - Heart
  - Carotid arteries
  - Thyroid
  - Mandible

Clinical example: Mantle Radiation

- Increased risk for:
  - Breast cancer
  - Coronary artery disease
  - Valvular disease
  - Stroke
  - Hypothyroidism and thyroid cancer
5-YR Survival Rates for Hodgkin Lymphoma, Ages 0-19


All-Cause Mortality, Hodgkin Lymphoma Diagnosis: 1970-1986

All-Cause Mortality, Hodgkin Lymphoma Diagnosis: 1970-1986


All-Cause Mortality, Hodgkin Lymphoma Diagnosis: 1970-1986

Cumulative incidence of breast cancer in HL survivors

Start screening at age 25


Breast Cancer Post RT

- Onset - 8 yrs post RT
- Median interval – 16 yrs post RT
- Median age at diagnosis – early 30’s
- 5-YR prognosis strongly associated with stage of disease at diagnosis
- Limitations in treatment options
  - Radiation
  - Anthracyclines
Mammogram Practices

- Current recommendation: annual screening mammogram starting at age 25 or 8 years after (chest) radiation
- Survey of 625 women in the CCSS, age 25-50, with a history of chest radiation
- 55% had mammogram in the past 2 years compared to 37% of non-cancer siblings
  - 36.5% age 25-39 years
  - 76.5% age 40-49 years

Oeffinger KC. JAMA 2009;301:404.

Mammogram Practices

- 47.3% had never had a mammogram
- 52.6% of those age 40-49 were being regularly screened (2 mammograms within 4 years)
- Screening rates were higher among women who reported a physician recommendation

Oeffinger KC. JAMA 2009;301:404.
EMPOWER

- Encouraging Mammography/MRI and Preventive Opportunities for Women Exposed to Radiation.
- Evaluate the effect of an intervention: mailed print materials and brief motivational interviews on mammogram and breast MRI
- Enrollment is ongoing

Clinical example: Splenectomy

- The spleen protects against encapsulated organisms such as pneumococcus, meningococcus, and hemophilus influenza.
- Without a spleen, the lifetime risk of overwhelming sepsis is 2-4%.
- Vaccination is available for these 3 organisms.
### Clinical example: Other treatments

- Doxorubicin (“Adriamycin”) can cause heart problems even years later.
- Bleomycin can cause lung problems.
- Blood transfusion given prior to 1992 could have transmitted Hepatitis C.

### Recommendations

- Annual labs
- An HCV Ab should be obtained once
- Referral to high-risk OB
- Echocardiogram/EKG annually; Pulmonary function testing with DLCO
- Breast MRI/mammogram annually
- Carotid artery dopplers with IMT baseline
- Yearly evaluation of skin in radiation field
- Prompt evaluation of any fever
Case Presentation

- Louis is a 18 year-old man with a history of acute lymphoblastic leukemia diagnosed at age 6.
- Treatment included: cyclophosphamide, daunorubicin (360mg/m2), and other chemotherapy, over the course of 2 ½ years.
- He also received 1800cGy cranial radiotherapy.

Case Presentation

- Today:
  - BMI 49.2
  - Waist circumference 138.5 cm
  - HDL 38
  - Triglycerides 223
  - Fasting glucose 92
  - Fasting insulin 53
  - HOMA-IR 12.1
Risk Factors for Obesity and Insulin Resistance after Cancer Treatment

- Cranial radiotherapy (CRT)
- Non CRT regimens for ALL
- Total body irradiation (TBI)
- Abdominal radiotherapy (Abd RT)
- Cisplatin
- Overweight prior to cancer diagnosis

ALL Survivors: Cardiovascular Risk Factors

<table>
<thead>
<tr>
<th>Cardiovascular Risk Factors</th>
<th>≥ 2 Risk Factors</th>
<th>≥ 3 Risk Factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group</td>
<td>OR</td>
<td>95% CI</td>
</tr>
<tr>
<td>Women</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DHS (reference)</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>ALLIFE CRT</td>
<td>3.42</td>
<td>1.14 to 10.59</td>
</tr>
<tr>
<td>ALLIFE no CRT</td>
<td>1.42</td>
<td>0.68 to 2.93</td>
</tr>
<tr>
<td>Men</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DHS (reference)</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>ALLIFE CRT</td>
<td>1.61</td>
<td>0.52 to 5.01</td>
</tr>
<tr>
<td>ALLIFE no CRT</td>
<td>0.61</td>
<td>0.29 to 1.29</td>
</tr>
</tbody>
</table>

Abbreviations: CVD, cardiovascular disease; ALL, acute lymphoblastic leukaemia; OR, odds ratio; DHS, Dallas Heart Study; CRT, cranial radiotherapy.

ALL Survivors: Insulin Resistance

![Scatter plot with geometric mean homeostasis model for assessment of insulin resistance (HOMA-IR) by group and sex. DHS, Dallas Heart Study; CRT, patients in the ALL-LIFE study who underwent cranial radiotherapy; no CRT, patients in the ALL-LIFE study who did not undergo CRT.]


ALL Survivors: Diabetes Mellitus

- A comparison of ALL survivors and siblings from the CCSS demonstrated an increased risk for diabetes mellitus, related to cranial radiation, partially attenuated by BMI.

<table>
<thead>
<tr>
<th></th>
<th>OR (95% CI)</th>
<th>P value</th>
<th>OR (95% CI)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Not adjusted for BMI</td>
<td>Adjusted for BMI</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No CRT</td>
<td>1.4 (0.7, 2.6)</td>
<td>0.34</td>
<td>1.3 (0.7, 2.6)</td>
<td>0.39</td>
</tr>
<tr>
<td>CRT</td>
<td>1.8 (1.2, 2.8)</td>
<td>&lt;0.01</td>
<td>1.6 (1.0, 2.5)</td>
<td>0.06</td>
</tr>
</tbody>
</table>

Leukemia Survivors: Cardiovascular Disease

<table>
<thead>
<tr>
<th>Congestive Heart Failure</th>
<th>Myocardial Infarction</th>
<th>Pericardial disease</th>
<th>Valvular disease</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hazard Ratio</td>
<td>$P$</td>
<td>Hazard Ratio</td>
<td>$P$</td>
</tr>
<tr>
<td>4.2</td>
<td>&lt;0.001</td>
<td>3.3</td>
<td>0.018</td>
</tr>
</tbody>
</table>


ALL Survivors: Stroke

<table>
<thead>
<tr>
<th>No CRT</th>
<th>CRT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cumulative Incidence (15 years)</td>
<td>0.44</td>
</tr>
<tr>
<td>95% CI</td>
<td>0.09,0.80</td>
</tr>
<tr>
<td>Cumulative Incidence (25 years)</td>
<td>0.44</td>
</tr>
<tr>
<td>95% CI</td>
<td>0.09,0.80</td>
</tr>
</tbody>
</table>

The RR of stroke was 6.4 (3.0, 13.8).
Strokes were observed even among survivors without a history of radiation.

Bowers DC et al. JCO 2006;24:5277-5282.
ALL Survivors:
Cardiovascular Risk Factors

<table>
<thead>
<tr>
<th>Risk Factor</th>
<th>Odds Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Obesity</td>
<td>*</td>
</tr>
<tr>
<td>Hypertension</td>
<td>*</td>
</tr>
<tr>
<td>Dyslipidemia</td>
<td></td>
</tr>
<tr>
<td>Diabetes</td>
<td>*</td>
</tr>
<tr>
<td>Any three risk factors</td>
<td></td>
</tr>
</tbody>
</table>


ALL Survivors: Hypertension

ALL Survivors: Hypertension

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Odds Ratio (Adjusted)</th>
<th>$P$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cisplatin</td>
<td>5.47</td>
<td>0.1</td>
</tr>
<tr>
<td>Cyclophosphamide</td>
<td>1.82</td>
<td>0.4</td>
</tr>
<tr>
<td>Ifosfamide</td>
<td>1.31</td>
<td>0.8</td>
</tr>
<tr>
<td>Anthracyclines and other chemotherapy</td>
<td>0.88</td>
<td>0.9</td>
</tr>
<tr>
<td>Abdominal radiotherapy</td>
<td>0.97</td>
<td>0.9</td>
</tr>
<tr>
<td>Cranial radiotherapy</td>
<td>0.58</td>
<td>0.5</td>
</tr>
<tr>
<td>Body mass index $\geq$ 25</td>
<td>6.89</td>
<td>0.02</td>
</tr>
</tbody>
</table>

Cardous-Ubbink et al. EJC 2010;46:782-790.

ALL Survivors: Dyslipidemia

- Among 110 ALL survivors (mean age, 24.3 years) mean LDL-c levels was 108.7 mg/dl.
- Yet, 36% (40) survivors had more than 50% of LDL cholesterol in small dense subfractions.
- Pattern B

ALL Survivors: Dyslipidemia

**Males**

<table>
<thead>
<tr>
<th></th>
<th>LDL Pattern A</th>
<th>LDL Pattern B</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>LDL-c</td>
<td>110.3</td>
<td>119.6</td>
<td>0.24</td>
</tr>
<tr>
<td>HDL-c</td>
<td>50.8</td>
<td>39.8</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Triglycerides</td>
<td>74.2</td>
<td>141.5</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

**Females**

<table>
<thead>
<tr>
<th></th>
<th>LDL Pattern A</th>
<th>LDL Pattern B</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>LDL-c</td>
<td>103.1</td>
<td>105.9</td>
<td>0.73</td>
</tr>
<tr>
<td>HDL-c</td>
<td>52.7</td>
<td>44.6</td>
<td>0.01</td>
</tr>
<tr>
<td>Triglycerides</td>
<td>87</td>
<td>173.3</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>
### ALL Survivors: Dyslipidemia

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>Pattern A</th>
<th>Pattern B</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Body mass index (BMI)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BMI &lt; 25 kg/m²</td>
<td>36</td>
<td>32 (88.9%)</td>
<td>4 (11.1%)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>BMI ≥ 25 kg/m²</td>
<td>74</td>
<td>38 (51.4%)</td>
<td>36 (48.6%)</td>
<td></td>
</tr>
<tr>
<td><strong>Waist circumference</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Normal</td>
<td>62</td>
<td>42 (67.7%)</td>
<td>20 (32.3%)</td>
<td>0.01</td>
</tr>
<tr>
<td>Increased</td>
<td>48</td>
<td>28 (58.3%)</td>
<td>20 (41.7%)</td>
<td></td>
</tr>
<tr>
<td><strong>Visceral pattern of obesity</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>VAT/SAT &lt; 0.4</td>
<td>85</td>
<td>61 (71.8%)</td>
<td>24 (28.2%)</td>
<td>0.05</td>
</tr>
<tr>
<td>VAT/SAT ≥ 0.4</td>
<td>19</td>
<td>5 (26.3%)</td>
<td>14 (73.7%)</td>
<td></td>
</tr>
<tr>
<td><strong>Insulin resistance</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HOMA-IR &lt; 2.86</td>
<td>43</td>
<td>33 (76.7%)</td>
<td>10 (23.3%)</td>
<td>0.03</td>
</tr>
<tr>
<td>HOMA-IR ≥ 2.86</td>
<td>67</td>
<td>37 (55.2%)</td>
<td>30 (44.8%)</td>
<td></td>
</tr>
<tr>
<td><strong>Metabolic syndrome</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>96</td>
<td>69 (72.9%)</td>
<td>27 (27.1%)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Yes</td>
<td>14</td>
<td>1 (7.1%)</td>
<td>13 (92.9%)</td>
<td></td>
</tr>
</tbody>
</table>

Prevalence of LDL pattern B by measures of body fat & insulin resistance/metabolic syndrome among 110 survivors of childhood leukemia.

What are the potential mediators for this clinical picture?
Potential Mediator: Diet

- Changes in appetite and dietary habits during treatment may have persistent effects ("life course model")
- The typical age of ALL patients may be especially relevant to their long-term eating habits; ALL survivors under the age of 5 at treatment were more likely to be obese in adulthood.

Reilly JJ, et al. JCEM 2001;86:3743-S.

Potential Mediator: Diet

- Poor adherence to dietary guidelines among 72 adult survivors of childhood ALL from the Childhood Cancer Survivor Study

American Cancer Society Dietary Recommendations

- Eat a healthy diet, with an emphasis on plant foods.
- Choose foods and drinks in amounts that help you get to and maintain a healthy weight.
- Limit processed meat and red meat.
- Eat at least 2½ cups of vegetables and fruits each day.
- Choose whole grains instead of refined grain products.
- If you drink alcohol, limit your intake.

www.cancer.org

Mediterranean Diet

- Overall mortality
- Diabetes mellitus
- Cardiovascular disease and stroke
- Alzheimer’s disease
- Cancer

Renaud Am J Clin Nutr 1995;61(Suppl):1360S.
Scarmeas Arch Neurol 2006;63:1709.
Estruch NEJM 2013; 368:1279-1290.
Primary end point: Acute MI, stroke, or death from cardiovascular cause.

Estruch NEJM 2013; 368:1279-1290.
Mediterranean Diet

<table>
<thead>
<tr>
<th></th>
<th>Med Diet EVOO N=2543</th>
<th>P</th>
<th>Med Diet Nuts N=2454</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary end point</td>
<td>0.70 (0.54,0.92)</td>
<td>0.01</td>
<td>0.72 (0.54,0.96)</td>
<td>0.03</td>
</tr>
<tr>
<td>Stroke</td>
<td>0.67 (0.46,0.98)</td>
<td>0.04</td>
<td>0.54 (0.35,0.84)</td>
<td>0.006</td>
</tr>
<tr>
<td>MI</td>
<td>0.80 (0.51,1.26)</td>
<td>0.34</td>
<td>0.74 (0.46,1.19)</td>
<td>0.22</td>
</tr>
<tr>
<td>CV Death</td>
<td>0.69 (0.41,1.16)</td>
<td>0.17</td>
<td>1.01 (0.61,1.66)</td>
<td>0.98</td>
</tr>
<tr>
<td>Death</td>
<td>0.82 (0.64,1.07)</td>
<td>0.15</td>
<td>0.97 (0.74,1.26)</td>
<td>0.82</td>
</tr>
</tbody>
</table>

Estruch NEJM 2013; 368:1279-1280.

Mediterranean Diet after ALL

- 117 adult survivors of childhood ALL
- Comprehensive metabolic testing
- Harvard food frequency questionnaire
- Adherence to the Mediterranean Diet plan was determined using the Med Diet Index

Trichopoulou et al. NEJM 2003; 348:2599.
Mediterranean Diet after ALL

- Greater adherence to a Mediterranean diet pattern was associated with:
  - Lower visceral adiposity \( (p = 0.07) \)
  - Less subcutaneous adiposity \( (p < 0.001) \)
  - Smaller waist circumference \( (p = 0.005) \)
  - Lower body mass index \( (p = 0.04) \).

Trichopoulou et al. NEJM 2003; 348:2599.

Mediterranean Diet after ALL

- For each point higher on the Mediterranean Diet Score, the odds of having the metabolic syndrome fell by 31% \( (OR \ 0.69; 95\% \ CI \ 0.50, 0.94; \ p = 0.019) \).

Trichopoulou et al. NEJM 2003; 348:2599.
Findings were independent of measured physical activity energy expenditure

Differences of 0.5 servings of vegetables a day, or one serving a fish a week, were associated with improved body mass index, adiposity, and blood pressure, and lower risk of the metabolic syndrome.
Mediterranean Diet

- Eat lots of: Fruits, vegetables, nuts, monounsaturated (versus saturated) fats, legumes, fish and seafood, whole grains
- Drink a little alcohol
- Don’t eat too much: meat or dairy


What about physical activity and cardiorespiratory fitness?
Physical activity

<table>
<thead>
<tr>
<th>Group</th>
<th>Not Meeting CDC Recommendations</th>
<th>Sedentary</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>OR</td>
</tr>
<tr>
<td>Males BRFSS</td>
<td>42078</td>
<td>1.0</td>
</tr>
<tr>
<td>ALL Survivors Chemo only</td>
<td>349</td>
<td>0.9</td>
</tr>
<tr>
<td>CRT &lt; 20 Gy CRT ≥ 20 Gy</td>
<td>339</td>
<td>1.3</td>
</tr>
<tr>
<td>CRT ≥ 20 Gy</td>
<td>352</td>
<td>1.4</td>
</tr>
<tr>
<td>Females BRFSS</td>
<td>58765</td>
<td>1.0</td>
</tr>
<tr>
<td>ALL Survivors Chemo only</td>
<td>424</td>
<td>1.3</td>
</tr>
<tr>
<td>CRT &lt; 20 Gy CRT ≥ 20 Gy</td>
<td>293</td>
<td>1.3</td>
</tr>
<tr>
<td>CRT ≥ 20 Gy</td>
<td>347</td>
<td>1.8</td>
</tr>
</tbody>
</table>

Florin et al. CEBP 2007;16:1356-1363
## Physical activity (PA)

<table>
<thead>
<tr>
<th>PA energy expenditure</th>
<th>Females (N=66)</th>
<th>Males (N=52)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>CRT N=25</td>
<td>No CRT N=41</td>
</tr>
<tr>
<td>Absolute, kcal/day†</td>
<td>671.5</td>
<td>551.4</td>
</tr>
<tr>
<td>Relative, kcal/kg/day†</td>
<td>9.8</td>
<td>8.0</td>
</tr>
<tr>
<td>PA duration, minutes/day†</td>
<td>202.6</td>
<td>161.8</td>
</tr>
<tr>
<td>3.0-4.9 METS†</td>
<td>95.9</td>
<td>80.4</td>
</tr>
<tr>
<td>5.0-6.9 METS†</td>
<td>3.8</td>
<td>3.2</td>
</tr>
<tr>
<td>≥ 7 METS†</td>
<td>0.1</td>
<td>0.1</td>
</tr>
</tbody>
</table>

## Cardiorespiratory Fitness

<table>
<thead>
<tr>
<th>NHANES Fitness Classification (ml/kg/min)</th>
<th>Females N=66 (%)</th>
<th>Males N=52 (%)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>ALL NHANES ALL NHANES</td>
<td>P</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low (&lt;20th percentile)</td>
<td>79.7</td>
<td>24.1</td>
<td>50.0</td>
</tr>
</tbody>
</table>

*Age and gender-specific norms for VO2 max values.

Tonorezos et al. PBC 2013, in press.
### Cardiorespiratory Fitness

<table>
<thead>
<tr>
<th>NHANES Fitness Classification (ml/kg/min)</th>
<th>Females N=66 (%)</th>
<th></th>
<th>Males N=52 (%)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>CRT N=25</td>
<td></td>
<td></td>
<td>CRT N=15</td>
<td></td>
</tr>
<tr>
<td>No CRT N=41</td>
<td></td>
<td></td>
<td>No CRT N=37</td>
<td></td>
</tr>
<tr>
<td>Low (&lt;20th)</td>
<td>96.0</td>
<td>0.03</td>
<td>92.3</td>
<td>0.05</td>
</tr>
</tbody>
</table>

*Age and gender-specific norms for VO2 max values.

**Table:**

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<th>Low (&lt;20th)</th>
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</tr>
</thead>
<tbody>
<tr>
<td>Females</td>
<td>96.0</td>
<td>67.5</td>
<td>92.3</td>
<td>52.8</td>
</tr>
<tr>
<td>Males</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Diagram:**

![Cardiorespiratory Fitness](image)

*Tonorezos et al. PBC 2013, in press.*
Summary of ALL Findings

- ALL survivors are at high risk for an altered cardiometabolic picture that contributes to MI, stroke, hypertension, and dyslipidemia.
- Survivors are likely to benefit from diet and physical activity intervention.

Contemporary Treatment

<table>
<thead>
<tr>
<th>Cancer</th>
<th>Treatment</th>
<th>Potential Late Effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hodgkin Lymphoma</td>
<td>ABVD chemotherapy, IMRT to involved field</td>
<td>Less infertility, fewer radiation-related effects, no splenectomy precautions</td>
</tr>
<tr>
<td>ALL</td>
<td>Chemotherapy regimens without anthracyclines and radiation for only highest risk or relapsed</td>
<td>Improved metabolic and cardiovascular picture, less risk of late-occurring CHF</td>
</tr>
<tr>
<td>AML</td>
<td>Chemotherapy to achieve remission followed by stem cell transplant</td>
<td>Lower doses of radiation, improved survival</td>
</tr>
</tbody>
</table>
Conclusions

- Cancer survivors face long-term risks
- Many are modifiable via
  - Screening
  - Surveillance
  - Diet and exercise
- Risk-based care may be able to reduce morbidity and mortality in this population.

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