Endocrinopathies Related to Cancer Therapy

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Conflict of Interest Disclosure

Presenter has:

- No relevant professional, personal or financial relationships to disclose
- No sponsorships or commercial support
- Will not be endorsing the use of any products or speaking to the off-label use of products
OBJECTIVES

➢ Describe the endocrine sequelae of childhood cancer therapies.
➢ Discuss the common risk factors for developing endocrinopathies after cancer treatment.
➢ Explain guidelines for monitoring, diagnosis and treatment.
The Scope of Childhood Cancer

- 11,500 new cases per year in the U.S. under the age of 15 (2020)
- 5,000-6,000 adolescents in the U.S. ages 15-19


Fig. 1. Relative frequencies for the main ICCC-3 diagnostic groups by age groups: (a) age <1 year; (b) age 1–4 years; (c) age 5–9 years; (d) age 10–14 years; (e) age 15–19 years. Kaatsch. Epidemiology of Childhood Cancer. 2010
Childhood Cancer & Survivorship

- 5-year survival rate has increased from 58% in the 1970s to 84% currently
- There are ~375,000 adult survivors of childhood cancer in the U.S. which equates to 1 in 530 adults ages 20-39.

Childhood Cancer Survival Study (CCSS)

- <21 at time of diagnosis, diagnosed between 1970-1986, and at least 5 years survival
  - leukemia, CNS cancers, HD, non-Hodgkin’s lymphoma, Wilms, neuroblastoma, sarcomas
- 14,000 survivors / 3,500 siblings; Expansion Cohort 11,000+
- Medical Record Abstraction and Questionnaires
Cumulative Toxicities from Childhood Cancer Treatment

• Endocrine Sequelae
Treatment Plan
<table>
<thead>
<tr>
<th>Sec #</th>
<th>Therapeutic Exposure</th>
<th>Potential Late Effects</th>
<th>Periodic Evaluation</th>
<th>Health Counseling/ Further Considerations</th>
</tr>
</thead>
<tbody>
<tr>
<td>52</td>
<td>Head/Brain TBI</td>
<td>Growth hormone deficiency</td>
<td>HISTORY: Assessment of nutritional status. Every 6 months until growth is completed, then yearly. PHYSICAL: Tanner staging. Every 6 months until sexually mature. Height. Weight. BMI. Every 6 months until growth is completed, then yearly.</td>
<td>HEALTH LINKS: Growth Hormone Deficiency Hypopituitarism. RESOURCES: <a href="http://www.magicfoundation.org">www.magicfoundation.org</a>. POTENTIAL CONSIDERATIONS FOR FURTHER TESTING AND INTERVENTION: For skeletally immature children, refer to endocrinology if radiation dose &gt;30 Gy. For those treated with &lt;30 Gy, obtain x-ray for bone age in poorly growing children. Endocrine consultation: Poor growth for age or stage of puberty as evidenced by decline in growth velocity and change in percentile rankings on growth chart, weight below 3rd percentile on growth chart. Evaluate thyroid function in any poorly growing child. Consult with endocrinologist regarding risks/benefits of adult growth hormone replacement therapy. Consider bone density testing in patients who are growth hormone deficient. SYSTEM = Endocrine/Metabolic SCORE = 1</td>
</tr>
</tbody>
</table>

**Additional Information**

Growth charts available on-line at www.cdc.gov/growthcharts.

- Patient factors: Younger age at treatment.
- Cancer/Treatment factors: Surgery in supra-sellar region, higher radiation dose (especially radiation dose >18 Gy), pretransplant radiation (especially pretransplant cranial radiation), TBI >10 Gy in single fraction, >12 Gy fractionated TBI given in single fraction.

**References**


Endocrine Sequelae: Clinical Pearls

- Highest risk patients are those treated with radiation & chemotherapy (In CNS tumors, the prevalence of an endocrinopathy is >70%)

- May be overlooked by the provider and the patient (after all they have gone through…)

- May not present for years to decades after Rx

- May not present as you would anticipate
The Pituitary

Figure Adapted From: National Taiwan Science Education Center
Endocrine Sequelae: Clinical Pearls

Possible Endocrinopathies
- GH deficiency
- Central Hypothyroidism
- Central Adrenal Insufficiency
- Hyperprolactinemia
- Precocious Puberty/Hypogonadotropic Hypogonadism
- Overweight/Obesity

Risk Factors
- Cranial Radiation
  - Hypothalamus more sensitive than pituitary
  - Higher radiation doses
  - Potentiating effects of chemotherapy, which may also have direct effects
- Surgery
- Younger age of treatment

Surveillance
- Monitor growth and pubertal development every 6 months
- Routinely monitor hormone levels
- Consider routine BA assessment in at-risk patients
## Table 1 Hypothalamic–pituitary axis dysfunction after cranial radiotherapy.

<table>
<thead>
<tr>
<th>Condition treated</th>
<th>Radiation schedule</th>
<th>Hypothalamic–pituitary axis dysfunction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leukemia and lymphoma</td>
<td>Fractionated TBI (7–16 Gy)</td>
<td>Isolated GHD, mostly in pubertal children</td>
</tr>
<tr>
<td>Leukemia and lymphoma</td>
<td>Fractionated prophylactic cranial irradiation (18–24 Gy)</td>
<td>Isolated GHD (&lt;30% of children only)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Pubertal GH insufficiency</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Compensated GHD in adults</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Increased spontaneous cortisol secretion</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Precocious puberty (girls only)</td>
</tr>
<tr>
<td>Nonpituitary brain tumors</td>
<td>Conventional fractionated cranial irradiation (30–50 Gy)</td>
<td>GHD (30–100%)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Compensated GHD in adults</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Precocious puberty (both sexes)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Gonadotropin deficiency (&gt;20% long-term)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>TSH deficiency (3–9% long-term)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Subtle abnormalities in TSH secretion (30%)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ACTH deficiency (3% long-term)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Increased spontaneous cortisol secretion</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Hyperprolactinemia (5–20%, mostly in women)</td>
</tr>
<tr>
<td>Nasopharyngeal carcinoma and skull-base tumors</td>
<td>Conventional fractionated cranial irradiation (50–70 Gy)</td>
<td>GHD (almost all patients after 5 years)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Gonadotropin deficiency (20–50% long-term)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>TSH deficiency (≤60% long-term)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ACTH deficiency (27–35% long-term)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Hyperprolactinemia (20–50%, mostly in women)</td>
</tr>
<tr>
<td>Pituitary tumors</td>
<td>Conventional fractionated cranial irradiation (30–50 Gy)</td>
<td>GHD (almost all patients after 5 years)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Gonadotropin deficiency (≤60% after 10 years)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>TSH deficiency (≤30% after 10 years)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ACTH deficiency (≤60% after 10 years)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Hyperprolactinemia (20–50%, mostly in women)</td>
</tr>
</tbody>
</table>
Conventional XRT

Stereotactic Radiosurgery

Proton Therapy
Growth and Final Adult Height

- Growth disturbance common and multifactorial
  - Poor Nutrition
  - GH deficiency
  - Illness in general
  - Growth velocity is diminished during all phases of therapy for childhood ALL--likely true for any tumor
  - Use of glucocorticoids
  - Other endocrinopathies (hypothyroidism, hypogonadism)

- Risk highest in survivors exposed to cranial or craniospinal RT, particularly those diagnosed <10 years
  - Adult short stature
  - 3-fold increase with XRT doses from 20 to 59 Gy
  - 6-fold increase with XRT doses from >59 Gy

- Spinal RT can directly damage the epiphyses and lead to disproportionate growth and short stature (late puberty growth failure)
GH Deficiency—A Common Sequela

- Directly related to dose of XRT and inversely related to age of exposure
- Clinical presentation may be subtle and may be manifested only by a diminished pubertal growth spurt
  - IGF1 levels may be normal
  - Be alert for concomitant precocious puberty, which may cause apparently normal growth
  - Obesity may also normalize growth with a disproportionate BA advance

**Table 2.** Multivariate Analysis of Risk of Disease Recurrence in Patients Treated With GH by Initial Diagnosis

<table>
<thead>
<tr>
<th>Diagnosis</th>
<th>RR</th>
<th>95% CI</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>CNS tumors</td>
<td>0.31</td>
<td>0.13 to 0.77</td>
<td>.01</td>
</tr>
<tr>
<td>Medulloblastoma</td>
<td>0.13</td>
<td>0.02 to 0.94</td>
<td>.04</td>
</tr>
<tr>
<td>Astroglial</td>
<td>0.98</td>
<td>0.35 to 2.75</td>
<td>.96</td>
</tr>
<tr>
<td>Ependymoma</td>
<td>0*</td>
<td>0 to 13</td>
<td>.41</td>
</tr>
<tr>
<td>Germ cell</td>
<td>†</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Acute leukemia</td>
<td>0.85</td>
<td>0.12 to 6.14</td>
<td>.87</td>
</tr>
<tr>
<td>Rhabdomyosarcoma</td>
<td>0^</td>
<td>0 to 4</td>
<td>.31</td>
</tr>
<tr>
<td>Neuroblastoma</td>
<td>0^</td>
<td>0 to 35</td>
<td>.73</td>
</tr>
</tbody>
</table>

Abbreviations: GH, growth hormone; RR, relative risk.

*No recurrences occurred after GH therapy in patients in these diagnostic groups and, thus, the RR estimate is 0. The 95% CIs are calculated using the offset method in the time-dependent Cox model.

†No recurrences occurred in either the GH- or non–GH-treated groups, therefore, the RR cannot be determined.

**Fig. 1.** The proportion of survivors who did not experience a recurrence of their primary cancer. Survivors treated with GH are compared with survivors who never received GH treatment.

<table>
<thead>
<tr>
<th>Covariate</th>
<th>RR (95% CI)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>GH</td>
<td></td>
<td>0.65</td>
</tr>
<tr>
<td>No</td>
<td>1.00</td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>0.83 (0.37–1.86)</td>
<td></td>
</tr>
</tbody>
</table>


Sklar CA et al. JCEM 87, 2002:3136–3141
Abnormal Puberty

- Girls may be more sensitive

- The spectrum ranges from CPP to gonadotropin deficiency to both
  - Lower XRT doses (PP, girls)
  - Higher doses (girls and boys; CPP, HH, or both)

- Rethink standard definitions of CPP (Is this child too short to be entering puberty?)

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Central Hypothyroidism

- Major Risk
  - Radiation dose ≥ 30 Gy

- Diagnosis difficult to make (particularly when mild)

- Can occur as an isolated event

- Low threshold for treatment
  - Rule out concomitant adrenal insufficiency

Secondary Adrenal Insufficiency (SAI)

- Occurs less frequently than other endocrinopathies

- Symptoms
  - Anorexia/FTT
  - Fatigue
  - Unexplained Hypotension, Dizziness
  - Nausea/Vomiting, Abdominal Pain
  - Hyponatremia, hyperkalemia, hypoglycemia (less frequent)

Children’s Oncology Group
Secondary Adrenal Insufficiency (SAI)

Risk Factors

- Radiation to the brain, especially in doses of 30Gy (3000 cGy) or higher, including the following fields:
  - Cranial (whole brain or focal to the central area of the brain, near the HPA)
  - Craniospinal (CSI)
  - Nasopharyngeal (nose and throat)
  - Oropharyngeal (mouth and throat)
  - Orbital
  - Eye
  - Ear
  - Infratemporal (midfacial area behind the cheekbones)
- Exogenous steroids (glucocorticoids, megestrol)
- Surgical removal of the pituitary gland
- CNS tumors
SAI - Management

➢ Treatment
  • PO medication: Hydrocortisone – BID - TID dosing

➢ Stress dose
  • When the body is under stress, a higher HTC dose may be indicated

➢ Early recognition of symptoms

Children’s Oncology Group
SAI - Screening

- Evaluate yearly for up to 15 years post-radiation, in pts who received >30 Gy (or as clinically indicated)
  - Random 8am cortisol level

- Factors of misdiagnosis or insufficient screening
  - Insufficient length of follow-up and testing methods
  - Relapse

- Improve screening
Hyperprolactinemia

- Major Risk
  - Radiation dose $\geq 40$ Gy

- Elevated prolactin levels
  - Galactorrhea in females
  - Hypogonadism in either gender

The Thyroid

Figure Adapted From: National Taiwan Science Education Center
Endocrine Sequela: The Thyroid

- **Possible Endocrinopathies**
  - Hypothyroidism
  - Hyperthyroidism
  - Benign Thyroid Nodules
  - Thyroid carcinoma (PTC)

- **Risk Factors**
  - Radiation to the head and neck
  - Surgery
  - Younger age of treatment
  - Female Gender

- **Surveillance**
  - Monitor TFTs
  - Perform annual thyroid examination
    - No routine ultrasound.
Hypothyroidism

- Most common thyroid Dx
- Direct damage to thyroid from XRT
- Hodgkin lymphoma, CNS tumor & soft tissue sarcoma survivors
- Chemo alone not a risk

Sklar C et al. JCEM 85(9) 2000.
Chemaitilly W & Sklar C Endocrine-Related Cancer 2010.
Hypothyroidism

- Major Risk Factors
  - Higher radiation dose
  - Female Gender
  - Surgery (+/- involving the thyroid gland)

- Not clear risk factors
  - Age
  - Chemotherapy

Vogelius Cancer 2011; 117:5250-60.
Hyperthyroidism

- XRT major risk factor
  - Thyroid dose ≥30 Gy
  - ?Radiation affects immune response

- 5% rate in a large HD study

- Mean Dx 8 years after cancer Dx

**TABLE 1.** Incidence of thyroid abnormalities in HD survivors compared to controls

<table>
<thead>
<tr>
<th>Abnormality</th>
<th>HD survivors</th>
<th>Controls</th>
<th>RR (95% CI)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Cases Rate/1000 py</td>
<td>Cases Rate/1000 py</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Underactive</td>
<td>456 0.6</td>
<td>39 0.6</td>
<td>17.1 (12.5–24.2)</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Overactive</td>
<td>82 1.6</td>
<td>13 0.2</td>
<td>8.0 (4.6–15.1)</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Nodules</td>
<td>146 2.9</td>
<td>7 0.1</td>
<td>27.0 (13.6–63.9)</td>
<td>&lt;0.0001</td>
</tr>
</tbody>
</table>

py, Person-years.

Sklar C et al. JCEM 85(9) 2000.
Gleeson et al. Best Practice & Res Clin Endo and Metab 16 (2) 2002.
Thyroid Neoplasia

Radiation-Induced Papillary Thyroid Cancer
## Thyroid Cancer as a Second Primary Malignancy (SPM)

Table 2. Standardized incidence ratios (SIR) of second and subsequent malignant neoplasms in the Childhood Cancer Survivor Study (CCSS) cohort

<table>
<thead>
<tr>
<th>Second/subsequent malignancy</th>
<th>SIR (95% CI)</th>
<th>Median time to occurrence (years)</th>
</tr>
</thead>
<tbody>
<tr>
<td>All second/subsequent malignancies</td>
<td>6.4 (5.7–7.1)</td>
<td>11.7</td>
</tr>
<tr>
<td>Acute myeloid leukemia</td>
<td>7.9 (3.6–15.0)</td>
<td>6.1</td>
</tr>
<tr>
<td>Lymphoma</td>
<td>1.5 (0.80–2.6)</td>
<td>13.8</td>
</tr>
<tr>
<td>Central nervous system tumor</td>
<td>9.9 (6.9–13.63)</td>
<td>9.5</td>
</tr>
<tr>
<td>Breast cancer</td>
<td>16.2 (12.2–20.8)</td>
<td>15.7</td>
</tr>
<tr>
<td>Bone cancer</td>
<td>19.1 (12.7–27.7)</td>
<td>9.6</td>
</tr>
<tr>
<td>Soft tissue sarcoma</td>
<td>6.3 (4.3–8.9)</td>
<td>10.6</td>
</tr>
<tr>
<td>Thyroid cancer</td>
<td>11.3 (8.2–15.3)</td>
<td>13.3</td>
</tr>
<tr>
<td>Melanoma</td>
<td>4.0 (2.4–6.3)</td>
<td>14.6</td>
</tr>
<tr>
<td>All other cancers</td>
<td>4.0 (3.1–5.2)</td>
<td>13.9</td>
</tr>
</tbody>
</table>

Adapted with permission from Neglia et al. [45••].

CI—confidence intervals; SIR—standardized incidence ratio.

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Screening for Thyroid Disease
COG LTFU guidelines

Thorough Review of Systems
Thyroid Dysfunction
- Annual TFT’s
  More frequently during periods of rapid growth

Thyroid Neoplasia
- Annual PE
- US and FNA if palpable nodule

H/O cervical radiation or systemic exposure to radiation (e.g. 131 MIBG)
Thyroid Neoplasia Screening via US

PROs
- Early Dx of Thyroid Cancer
  - Identifies disease when curable
  - ??prevent death from thyroid cancer

CONs
- Incidental thyroid findings common
- Benign thyroid disease >>> cancer
- ↑↑ anxiety among patients/families (and health care providers)
- Potential over-testing & over-treatment
The Parathyroids

Pituitary

Thyroid

Parathyroid

Adrenal

Pancreas

Gonad
Endocrine Sequelae: The Parathyroids

- Possible Endocrinopathies
  - Primary Hyperparathyroidism
  - Hypoparathyroidism

- Risk Factors
  - Radiation
  - Younger age of treatment

- Surveillance
  - None recommended during childhood as the latency period is quite long (>25 yrs)

Gleeson et al. Best Practice & Res Clin Endo and Metab 16 (2) 2002.
The Pancreas
Endocrine Sequelae: Metabolism

- Possible Endocrinopathies

- Risk Factors
  - Previous ALL, CNS tumor, stem cell transplant
  - Decreased physical activity/Inability to exercise
  - Radiation (≥18Gy) and/or surgery impacting neuroendocrine axis; TBI
  - Younger age (<4 years) at radiation
  - Chronic glucocorticoid use
  - Genetic background

- Surveillance
  - Monitor weight, BMI, and blood pressure annually
  - Evaluate for other co-morbid conditions, including dyslipidemia, hypertension and impaired glucose metabolism.
Risk of DM in the CCSS

Childhood cancer survivors treated with TBI or abdominal irradiation have an increased risk of diabetes that appears unrelated to body mass index or physical inactivity.

The Gonads
Possible Endocrinopathies
- Primary Ovarian Failure - Low sex steroids and germ cell failure
- Primary Testicular Failure - Germ cell failure ± low sex steroid production

Risk Factors
- Radiation
  Girls: Older age of radiation
  - Prepubertal female: Radiation dose ≥10 Gy
  - Pubertal female: Radiation dose ≥5 Gy
  Boys: Age not as critical
  - >12 Gy testicular exposure may cause hormonal dysfunction
  - Up to 6 Gy azoospermia may be transient; > 6 Gy azoospermia is likely permanent

  Both: Potentiating effects of cyclophosphamide conditioning for BMT
- Surgery
- Chemotherapy: Alkylating agents

Surveillance
- Monitor pubertal development q 6-12 months depending on age of patient
- LH/FSH & either estradiol or testosterone levels as clinically indicated in patients with delayed/arrested puberty (age 13 girls, age 14 boys)
Fig. 8. Potential targets for impairment of fertility following chemotherapy and/or radiotherapy.
Case #1, August 2005, Age 19

What endocrinopathies is this patient at risk for?
Case #1 August 2005 Age 19

<table>
<thead>
<tr>
<th>Test</th>
<th>Value</th>
<th>Reference Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>T4 (THYROXINE),FREE</td>
<td>0.8 NG/DL</td>
<td>(0.9-1.8)</td>
</tr>
<tr>
<td>TSH</td>
<td>9.56 MCU/ML</td>
<td>(0.50- 5.50)</td>
</tr>
<tr>
<td>IGF-1</td>
<td>287 ng/mL</td>
<td>(182-780)</td>
</tr>
<tr>
<td>CALCIUM</td>
<td>9.8 MG/DL</td>
<td>(8.4- 10.2)</td>
</tr>
<tr>
<td>PHOSPHORUS</td>
<td>3.8 MG/DL</td>
<td>(2.8- 4.6)</td>
</tr>
<tr>
<td>GLUCOSE</td>
<td>99 MG/DL</td>
<td>(70- 110)</td>
</tr>
<tr>
<td>LH</td>
<td>19.3 H MIU/ML</td>
<td>(1.7- 11.2)</td>
</tr>
<tr>
<td>FSH</td>
<td>20.7 MIU/ML</td>
<td>(1.0- 42.5)</td>
</tr>
<tr>
<td>TESTOSTERONE</td>
<td>180L NG/DL</td>
<td>(241- 827)</td>
</tr>
</tbody>
</table>
What endocrinopathies can be identified?

What do you do now?
Case #2

12 yo Caucasian female with history of Wilms tumor
Age at diagnosis: 22 months
Treatment included:
- Chemotherapy - Vincristine, actinomycin-D, and Adriamycin.
- Radiation - Abdominal (unknown dose)
- Surgery - Nephrectomy, liver biopsy and exploratory laparotomy

Chief complaint: short stature
Physical examination:
- Height 143 cm (~3%ile) (MPH at 90%ile)
- Tanner I breast; Tanner II PH
- BA < CA by almost two years

What endocrinopathies is this patient at risk for?
Case #2

FSH 158.6 MIU/ML
Postmenopausal 25.0 -160.0

IGF-1 270 NG/ML
(261-1096)

TSH 2.27 MCU/ML
(0.50-5.50)

LH 34.5 MIU/ML
Postmenopausal 14.4 -62.2

Free T4 1.0 NG/DL
(0.9-1.8)

IGFBP 3 1.8 L mg/L
2.2-4.2
Case #2

What is the diagnosis?

How would you treat?
Case # 3

13yo Asian-American female with history of multiply relapsed medulloblastoma

Age at diagnosis: 6 years

Treatment included:

Initial Diagnosis
- Chemotherapy – Vincristine, Cisplatin, Cyclophosphamide, Lomustine
- Radiation – CSI 18 Gy w/ PF boost to 55.8 Gy

1st Relapse
- Chemotherapy – Etoposide, Sorafenib
- Re-irradiation – CSI 24 Gy

2nd Relapse
- Chemotherapy – Carboplatin
- Re-irradiation – Focal to PF tumor in brain 30 Gy, followed

3rd Relapse
- Chemotherapy – Temodar combined with oral immunotherapy
- Re-irradiation – Focal to spinal cord tumors to 30 Gy

4th Relapse
- Chemotherapy – Cyclophosphamide and Etoposide, combined with oral immunotherapy

Presentation: extreme fatigue, lactic acidosis, hypotension, hyponatremia

H&P:
- Height 121.8 cm (~25%ile)
- Weight 21.6 kg (<5th %ile)
- Hx of anorexia/FTT
- Intermittent dyspnea
- Somnolence

What endocrinopathies is this patient at risk for?
Case # 3

What is the diagnosis?

How would you treat?
Conclusions

- Endocrine late effects occur in 50-60% of childhood cancer survivors

- It may take years-decades to recognize a late effect

- Advanced Practice Registered Nurses are uniquely positioned to follow the growing population of cancer survivors.
QUESTIONS?