Linear Growth Assessment:
Evaluation and Causes and Treatment of Growth Failure

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“Growth is the single most important indication of the health of a child.”
(Tanner 1970)

“The heights measured in the average casual clinic are useless even for accurate clinical purposes, let alone research.”
(Tanner 1986)

Importance of growth assessment
- Single most important indication of health of a child
- Simple, non invasive, well understood
- Short stature is a symptom, not a disease
- Most short children are normal
- Must know the normal to know the abnormal
CORRECT MEASURING
TECHNIQUE

- Shoes off
- Hats/ hair ornaments removed
- Head inline with headplate
- Feet together
- Feet, shoulders, buttocks in contact with hard surface
- Gentle traction beneath jaw
- Footplate against soles of feet (length only)
A MULTICENTER RANDOMIZED CONTROLLED TRIAL TO IMPROVE THE ACCURACY OF LINEAR GROWTH MEASUREMENT

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Factors Associated with Inaccurate Linear Measurements

- Faulty Equipment
- Faulty Technique
- Faulty Standards or Practice

Study Objectives

- Assess measurement techniques in PCP practices
- Evaluate effect of an intervention program on measurement accuracy

Eight Study Sites of 1st Multi-Center Study
SAMPLE

<table>
<thead>
<tr>
<th>Practices</th>
<th>Measures</th>
<th>Children Measured</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline</td>
<td>55 (11 FP, 44 PP)</td>
<td>127 307</td>
</tr>
<tr>
<td>3 Months</td>
<td>55 (11 FP, 44 PP)</td>
<td>112 282</td>
</tr>
<tr>
<td>6 Months</td>
<td>53 (10 FP, 43 PP)</td>
<td>107 289 878</td>
</tr>
</tbody>
</table>

Accurate Equipment and Correct Technique

Equipment used to measure 42% of study population
Results: Effect of Intervention on Technique

\[ p < 0.0005 \quad p < 0.0005 \]
Results: Effect of Intervention on Accuracy

<table>
<thead>
<tr>
<th>Group</th>
<th>Baseline</th>
<th>3 Months</th>
<th>6 Months</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>X Diff. (SD)</td>
<td>X Diff. (SD)</td>
<td>X Diff. (SD)</td>
</tr>
<tr>
<td>C (n)</td>
<td>1.3 cm (1.6) (n = 169)</td>
<td>1.0 cm (0.9) (n = 155)</td>
<td>1.1 cm (1.4) (n = 157)</td>
</tr>
<tr>
<td>I (n)</td>
<td>1.2 cm (1.2) (n = 138)</td>
<td>0.6 cm (0.7) (n = 127)</td>
<td>0.5 cm (0.8) (n = 132)</td>
</tr>
</tbody>
</table>

p = 0.0001 p < 0.0005

Measurement Accuracy: Educational Background of Measurer

Dissemination of Growth Research

- Reuters Health
- Growth, Genetics and Hormones
- Associated Press
- International Herald Tribune
- New York Times
- Los Angeles Times
- Philadelphia Inquirer
- Parents’ Magazine
- American Baby
- Women’s Day
- Action News- ABC TV
- KYW radio
Plotting on growth charts
How to Plot
Evaluation of Growth Disorders

History and Physical Examination
- Birth History - Small for Gestational Age, Intrauterine Growth Retardation
- General History - Chronic Illness
- Family History - Genetic, Psychosocial
- Physical Examination - Proportions, Abnormalities
- Growth Chart - Growth Velocity, Age of Onset, Change in Growth Pattern

Normal Growth Rates
- Average Newborn- 20"
- Growth in First Year- 10"
- Growth in Second Year- 5"
- Growth Each Year From Age Two until Puberty- 2 1/2"
Sequence of pubertal events

Normal growth rates during childhood

Definition of growth failure (3 yr - puberty)
- Height less than the 3rd %
- Growth less than 4 cm /yr
- Height deceleration- crossing percentiles
Frequency of referrals

- Number of children referred: 182 Boys, 96 Girls
- P < 0.00005

Causes of short stature

- Normal short child
  - Genetic short stature
  - Constitutional growth delay

Genetic/ Familial Short Stature

- Annual Growth Rate Normal
- 3rd-5th Percentile
- No Systemic or Endocrine Disease
- Pubertal Growth Spurt at Normal Age
- Skeletal Age Equal to Chronological Age
- Ancestors Relatively Short
Constitutional Growth Delay (Delayed Puberty)

- Height at or Below 3rd Percentile
- Annual Growth Rate < 5 cm/yr
- Normal Physical Examination
- Pubertal Delay
- Skeletal Age Delay
- Positive Family History
PSYCHOSOCIAL DEPRIVATION

- Often difficult to distinguish from organic hypopituitarism
- Parents may display aberrant social behavior
- Patients may exhibit bizarre eating and drinking habits
- Endocrinologic hormone tests (e.g., GH stimulation test) usually return to normal on removal from environment
Nonendocrine causes of growth failure

Small for Gestational Age

**DEFINITION**
- Infants with birth weight >2 standard deviation below the mean for gestational age (corrected for sex and race)

**POSSIBLE OUTCOMES**
- Permanent short stature
- Catch-up growth after birth
- Indication for growth hormone treatment
Associated abnormalities

- Aortic valve stenosis
- Coarctation of the aorta
- Bicuspid aortic valve
- Horseshoe kidney
- Visual impairments - sclera, cornea, glaucoma, etc.
- Ear infections and hearing loss
TURNER SYNDROME
Demographics of Turner Syndrome

- Most common sex chromosome abnormality of females
- Affects approximately 3% of all female conception
- 1/2,500 live-born females
- 1/100 fetuses with 45,X karyotype survive to term; approximately 15% of spontaneous abortions
- 50,000-100,000 girls and women in the United States are affected

TURNER SYNDROME
45,XO CHROMOSOMES

- 1/2500 female births
- Delayed Sexual Maturation
- Elevated LH, FSH
- Abnormal chromosomes
- Indication for growth hormone treatment

CHRONIC SYSTEMIC DISEASES

- Renal (indication for growth hormone treatment), gastrointestinal, cardiopulmonary, hematologic, etc.
- Abnormal bun/creatinine, CBC, sweat test, etc.
- CRF indication for growth hormone therapy
Skeletal Achondroplasia/dysplasia

DISORDERS OF BONE FORMATION

- Appear Disproportionate
- Have Extreme Short Stature
- Abnormal Skeletal Survey
Miscellaneous Causes of Growth Failure

- Other Chromosomal Abnormalities
- Nutritional Disorders
- Various Syndromes
- Metabolic Disorders
- Pharmaceuticals

Endocrine causes of growth failure

Thyroid Hormone Deficiency

Hypothyroidism- causes

- Congenital defect
  - Athyrosis
  - Ectopic thyroid
- Acquired hypothyroidism
  - Autoimmune- Hashimoto thyroiditis

HYPOTHYROIDISM- Symptoms

- May c/o constipation, cold intolerance, sluggishness, weight gain
- Skeletal maturation is markedly delayed
- Thyroid hormone levels (T3, T4) are decreased
- TSH may be elevated or low
Evaluation

- T4, T3 by RIA, TSH
- Thyroid peroxidase, thyroglobulin antibodies
- Thyroid scan
- Bone age x-ray

Treatment

- Thyroid hormone (Levoxyl) - 25-150 mcg qd (3-5 mcg/kg)
- Multiple doses for titration (colors)
- Method of infant dosing is crucial
Etiology

- Idiopathic
- Hereditary
- Embryologic Defects
- CNS Tumors
- Irradiation
- Trauma

Incidence

- 1/3800 live births- congenital GHD
- 50,000??? Currently treated for numerous indications
Ethnicity of Patients Starting GH vs. US Population ≤ 14 Years of Age - NCGS - n=64,020

STIGMATA
- Frontal Bossing
- Depressed Nasal Bridge
- High Pitched Voice
- Truncal Obesity
- Hypogonadism
- "Doll-like" faces
Diagnostic Studies

- Insulin-like Growth Factors
- Provocative Stimulation Tests
- 24-hour Growth Hormone Secretion

Growth Hormone Stimulation Tests

- Arginine
- L-Dopa/Propranolol
- Glugagon
Dosage and Administration

- 0.25-0.45 mg/kg/wk
- Most commonly- 6-7 days/wk- subcutaneously
FDA approved uses for Growth Hormone Treatment

- Childhood growth hormone deficiency
- Chronic Renal Insufficiency
- HIV wasting
- Adult growth hormone deficiency
- Turner Syndrome
- Prader Willi Syndrome

FDA approved uses for Growth Hormone Treatment

- Idiopathic short stature
- Short bowel syndrome
- SGA
- SHOX gene deficiency
- Noonan Syndrome
Nursing Interventions:
Normal Short Child

- Behave Toward Child in an Age Appropriate Manner
- Explain Need for Patience in Child with CGD
- Discourage Unattainable Goals
- Emphasize Child's Accomplishments
- May be eligible for growth hormone treatment

Nursing Interventions:
Child with Growth Hormone Deficiency

- Explain and Perform Stimulation Tests
- Instruct Child/Family on GH Administration
- Encourage Realistic Expectations

Nursing Interventions:
Untreatable Short Stature

- Emphasis Accomplishments Famous Short People
- Discuss Intelligence vs. Stature
- Refer to Counseling if Necessary
Heightism

Prejudice and Discrimination based on height (usually short stature)

What are the causes of heightism?

- Animal kingdom - small size associated with weakness and vulnerability
- Primitive physical advantage of larger people - better warriors/ hunters
- Greater height associated with superiority, strength, confidence
- Does heightism cluster with other “isms” - sexism and racism?

Mothers’ perceptions of competence (Eisenberg et al, 1984)

- 200 mothers rated cognitive and social abilities of 19-20 mo toddlers
- Photographs - only varied in height
  - Large boys rated more competent
  - Large girls rated more competent (lesser extent)
“Short Guys Finish last”, The Economist, 1995

- Discrimination based on height more pronounced than based on race, religion and gender
- More than 1/2 Fortune 500 CEO’s > 6” tall
- Posted on www.shortsupport.org
- Touchstone for SHRIMPs ( Severely Height Restricted Individuals of the Male Persuasion)

Presidential Height Index

- "Kerry’s height is such a concern for Bush that they will either do their debates sit down style, Bush will use a box to stand on, or as has happened before, they will prevent the networks from showing them right next to each other". TIME Magazine
- George Bush 5’11’
- John Kerry 6’ 4’
5'7" vs 6'1"

5'6" 6'2"