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)

Assessment of Growth:

OBTAINING ACCURATE MEASUREMENTS OF LENGTH IN NEONATES, INFANTS, AND CHILDREN
Aged Birth to 36 Months
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
<table>
<thead>
<tr>
<th></th>
<th>Practices</th>
<th>Measurers</th>
<th>Children Measured</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline</td>
<td>55 (11 FP, 44 PP)</td>
<td>127</td>
<td>307</td>
</tr>
<tr>
<td>3 Months</td>
<td>55 (11 FP, 44 PP)</td>
<td>112</td>
<td>282</td>
</tr>
<tr>
<td>6 Months</td>
<td>53 (10 FP, 43 PP)</td>
<td>107</td>
<td>289</td>
</tr>
</tbody>
</table>

Accurate Equipment and Correct Technique

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

<table>
<thead>
<tr>
<th></th>
<th>Trained</th>
<th>Not Trained</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>40</td>
<td>30</td>
</tr>
<tr>
<td>2</td>
<td>50</td>
<td>40</td>
</tr>
<tr>
<td>3</td>
<td>60</td>
<td>50</td>
</tr>
</tbody>
</table>

p < 0.0005  p < 0.0005
Results: Effect of Intervention on Accuracy


<table>
<thead>
<tr>
<th>Group</th>
<th>Baseline X Diff. (SD)</th>
<th>3 Months X Diff. (SD)</th>
<th>6 Months X Diff. (SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</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</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
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:
  - Boys: 182
  - Girls: 96

- 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
Bone Age

Male, 8 years
Male, 14 years

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
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

Gender of Patients Starting GH NCGS

[Graph showing gender distribution of patients starting GH from 1995 to 2003]
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

Growth hormone injections
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’
Pediatric Endocrinology Nursing Society (PENS)

The Pediatric Endocrinology Nursing Society is committed to the advancement of the art and science of pediatric endocrinology nursing. This includes the establishment and continued development of standards of practice, the enhancement of nursing research, the advancement of clinical expertise, and the promotion and recognition of excellence in nursing practice.

www.PENS.org