GROW 2015 Pediatric Calculations:
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Objectives

• Recognize appropriate growth chart for specific age range

• Accurately plot and interpret an anthropometric measurement on a growth chart

• Adjust for prematurity utilizing corrected gestational age equation

• Assess growth velocity
Objectives

• Determine energy, protein and fluid needs for the pediatric patient

• Apply catch up growth equation to determine energy needs

• Accurately calculate Breastmilk fortification

• Accurately calculate formula fortification
Growth Charts

• World Health Organization (WHO)
  – 0-2 years of age
  – Based on 17 countries
  – Wt/age, length/age, HC/age, wt/length

• Center for Disease Control and Prevention (CDC)
  – 2-20 years of age
  – Based on USA
  – Wt/age, height/age, BMI/age
Growth Charts

• Fenton
  - Preterm Infant
  - 22 weeks preterm until 20 weeks post term
  - Revised to accommodate the WHO Growth Standard and reflect actual age instead of completed weeks, in order to improve preterm infant growth monitoring

• Specialty growth charts
  – Cerebral Palsy
  – Down’s Syndrome
  – Achondroplasia
  – ?? Others?
Plotting Points On The Growth Chart

• Lets Practice!

• What does it all mean?
  – 5-85\textsuperscript{th}\%tile - normal
  – <5\textsuperscript{th}\%tile - underweight
  – 85-95\textsuperscript{th}\%tile - overweight
  – >95\%tile - obese

Great Job!
Correcting for Gestational Age (CGA)

- What do we consider “preterm?”
  - Born less than 37 weeks

- Until what age do we correct for prematurity?
  - Up until 24 months of corrected gestational age for weight
  - Up until 40 months of corrected age for length

- How do we adjust for corrected gestational age?
  - Adjust for prematurity = 40 weeks (term) - gestational age at birth
  - Corrected gestational age = chronological age - adjustment for prematurity
Case Study Example

• Baby Henry is a 4 month infant, admitted into the hospital for poor growth. He was born at 34 weeks gestation.
Case Study Example

• What is baby Henry’s corrected gestational age?

• **Step 1:**
  40 weeks - gestational age at birth **34 weeks** = 6 weeks for adjustment

• **Step 2:**
  Current # of months **4 months** X 4.3 weeks/month = **17.2 weeks**
Case Study Example

• **Step 3:**
  Current age in weeks **17.2 weeks** - weeks for adjustment **6 weeks** = **11.2 weeks corrected gestational age**

• **Step 4:**
  Convert decimal values **0.2** to days: **0.2 weeks X 7 days per week**= **1.4 days OR 11 weeks + 1 days corrected gestational age (~2.5 months)**
Assessing Growth Velocity

• What does it mean?
  – Way of identifying if the baby/child is growing at expected rate
  – Will determine if further nutrition interventions are indicated

• Why do we care?
  – Our children need to GROW!
Assessing Growth Velocity

• How can we calculate growth velocity?
  – Current weight (kg) - past weight (kg)
  – Convert answer into grams
  – Divide number of grams by number of days = gm/day

*Same method used to calculate Length and Head Circumference
### Assessing Growth Velocity

<table>
<thead>
<tr>
<th>Age</th>
<th>Weight (grams)</th>
<th>Height (cm/week)</th>
<th>FOC (cm/week)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Premie&lt;2 kg</td>
<td>15 – 20 g/kg/day</td>
<td>0.8 – 1.1</td>
<td>0.8 – 1</td>
</tr>
<tr>
<td>Premie&gt;2 kg</td>
<td>20 – 30 g/day</td>
<td>0.8 – 1.1</td>
<td>0.8 – 1</td>
</tr>
<tr>
<td>0 – 4 months</td>
<td>23 – 34 g/day</td>
<td>0.8 – 0.93</td>
<td>0.38 – 0.48</td>
</tr>
<tr>
<td>4 – 8 months</td>
<td>10 – 16 g/day</td>
<td>0.37 – 0.47</td>
<td>0.16 – 0.2</td>
</tr>
<tr>
<td>8 – 12 months</td>
<td>6 – 11 g/day</td>
<td>0.28 – 0.37</td>
<td>0.08 – 0.11</td>
</tr>
<tr>
<td>12 – 16 months</td>
<td>5 – 9 g/day</td>
<td>0.24 – 0.33</td>
<td>0.04 – 0.08</td>
</tr>
<tr>
<td>16 – 20 months</td>
<td>4 – 9 g/day</td>
<td>0.21 – 0.29</td>
<td>0.03 – 0.06</td>
</tr>
<tr>
<td>20 – 24 months</td>
<td>4 – 9 g/day</td>
<td>0.19 – 0.26</td>
<td>0.02 – 0.04</td>
</tr>
<tr>
<td>2 – 6 years</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6 – 10 years</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

While growth patterns vary among children, from ages 2 years to puberty, children gain an average of 2-3 kg (4.6-6.5 pounds) and grow in height 5-8 cm (2.5-3.5 in) per year.
Baby Henry was born on May 17, 2015 weighing 2 kg
On admission, September 15, 2015, his weight was reported at 3.5 kg
Length 55 cm and Head Circumference 40 cm
Assessing Growth Velocity

• What is his **daily** average weight gain since birth?

• **Growth velocity:**
  – Take current wt (3.5 kg) - birth weight (2.0kg) = wt change 1.5 kg
  – Find grams of weight (1.5 kgX1000g/kg)= 1500g
  – Find number of days since birth= ~120 days
  – Find the weight change since birth: 1500 g/120 days = 12.5 g/day

Goal weight gain = 25-35 g/day
• Not meeting goal for growth 😞
Assessing Growth Velocity

• Linear growth
  – Take current length (55 cm) - birth length (45 cm) = 10 cm
  – Find number of weeks since birth= 17.2
  – Find the length change since birth: 10 cm/17.2 weeks = 0.6 cm/wk

Goal linear growth velocity = 0.8 - 0.9 cm/week
• Slightly below goal for growth
Assessing Growth Velocity

- Head Circumference (HC)
  - Take current length (40 cm) - birth length (32 cm) = 8 cm
  - Find number of weeks since birth = 17.2
  - Find the length change since birth: 8 cm/17.2 weeks = 0.5 cm/wk

Goal HC growth velocity = 0.38 - 0.48 cm/week
- Meeting goal!
Assessment of Energy Needs

Dietary Reference Intakes (DRI)

- Used for 0-2 years of age
- Based on energy needs for healthy children
- See reference table

Schofield Equation - Basal Metabolic Rate (BMR)

- Can be used in children >2 years of age
- Stress factors?
# Assessment of Energy Needs

## Estimated Energy and Protein Requirements for Infants through Adolescents

<table>
<thead>
<tr>
<th>Age (years)</th>
<th>Reference Weight (kg)</th>
<th>Reference Height (cm)</th>
<th>BMR (kcal/kg/day)</th>
<th>DRI - Energy (g/day)</th>
<th>DRI - Protein (g/kg/day)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 – 2 mo</td>
<td>N/A</td>
<td>N/A</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>2 – 3 mo</td>
<td>6</td>
<td>62</td>
<td>54</td>
<td>609</td>
<td>9.1</td>
</tr>
<tr>
<td>4 – 6 mo</td>
<td>6</td>
<td>62</td>
<td>54</td>
<td>490</td>
<td>9.1</td>
</tr>
<tr>
<td>7 – 12 mo</td>
<td>9</td>
<td>71</td>
<td>51</td>
<td>723</td>
<td>11</td>
</tr>
<tr>
<td>13 – 35 mo</td>
<td>12</td>
<td>86</td>
<td>56</td>
<td>988</td>
<td>13</td>
</tr>
<tr>
<td>3 y/o</td>
<td>12</td>
<td>86</td>
<td>57</td>
<td>1020</td>
<td>13</td>
</tr>
<tr>
<td>4 – 5</td>
<td>20</td>
<td>115</td>
<td>48</td>
<td>1402</td>
<td>19</td>
</tr>
<tr>
<td>6 – 7</td>
<td>20</td>
<td>115</td>
<td>48</td>
<td>1279</td>
<td>19</td>
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<td>8</td>
<td>20</td>
<td>115</td>
<td>48</td>
<td>1186</td>
<td>19</td>
</tr>
<tr>
<td>3 y/o</td>
<td>12</td>
<td>86</td>
<td>55</td>
<td>986</td>
<td>13</td>
</tr>
<tr>
<td>4 – 5</td>
<td>20</td>
<td>115</td>
<td>45</td>
<td>1291</td>
<td>19</td>
</tr>
<tr>
<td>6 – 7</td>
<td>20</td>
<td>115</td>
<td>45</td>
<td>1229</td>
<td>19</td>
</tr>
<tr>
<td>8</td>
<td>20</td>
<td>115</td>
<td>45</td>
<td>1183</td>
<td>19</td>
</tr>
<tr>
<td>9 – 11</td>
<td>32</td>
<td>144</td>
<td>36</td>
<td>1756</td>
<td>19</td>
</tr>
<tr>
<td>12 – 13</td>
<td>35</td>
<td>144</td>
<td>36</td>
<td>1599</td>
<td>19</td>
</tr>
<tr>
<td>14 – 16</td>
<td>50</td>
<td>174</td>
<td>28</td>
<td>2385</td>
<td>52</td>
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<tr>
<td>17 – 18</td>
<td>50</td>
<td>174</td>
<td>28</td>
<td>2230</td>
<td>52</td>
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<tr>
<td>&gt; 18</td>
<td>70</td>
<td>177</td>
<td>28</td>
<td>2550</td>
<td>56</td>
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<tr>
<td>9 – 11</td>
<td>37</td>
<td>144</td>
<td>32</td>
<td>1567</td>
<td>34</td>
</tr>
<tr>
<td>12 – 13</td>
<td>37</td>
<td>144</td>
<td>32</td>
<td>1490</td>
<td>34</td>
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<tr>
<td>14 – 16</td>
<td>50</td>
<td>174</td>
<td>28</td>
<td>1760</td>
<td>46</td>
</tr>
<tr>
<td>17 – 18</td>
<td>50</td>
<td>174</td>
<td>28</td>
<td>1684</td>
<td>46</td>
</tr>
<tr>
<td>&gt; 18</td>
<td>57</td>
<td>177</td>
<td>28</td>
<td>1939</td>
<td>46</td>
</tr>
</tbody>
</table>

*Note: BMR values are based on the Schofield equation.*
# Assessment of Energy Needs

**Schofield Equation For Males**

<table>
<thead>
<tr>
<th>Age</th>
<th>W=weight in kg; H=height in cm.</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 3 years</td>
<td>0.167W + 15.174H - 617.6</td>
</tr>
<tr>
<td>3-10 years</td>
<td>19.59W + 1.303H + 414.9</td>
</tr>
<tr>
<td>10-18 years</td>
<td>16.25W + 1.372H + 515.5</td>
</tr>
<tr>
<td>18-30 years</td>
<td>15.057W - 0.1H + 705.8</td>
</tr>
</tbody>
</table>
### Assessment of Energy Needs

#### Schofield Equation For Females

<table>
<thead>
<tr>
<th>Age</th>
<th>Equation</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 3 years</td>
<td>$16.252W + 10.232H - 413.5$</td>
</tr>
<tr>
<td>3-10 years</td>
<td>$16.969W + 1.618H + 371.2$</td>
</tr>
<tr>
<td>10-18 years</td>
<td>$8.365W + 4.65H + 200.0$</td>
</tr>
<tr>
<td>18-30 years</td>
<td>$13.623W + 2.83H + 98.2$</td>
</tr>
</tbody>
</table>

W=weight in kg; H=height in cm.
Let’s Practice

• Using your DRI table, estimate energy needs for a 1 year old girl, weighing 12 kg
  – 82 kcals/kg/day x 12 kg = 984 kcals/day

• Using Schofield equation, estimate energy needs for a 5 year old boy who is post operative. His weight is 18 kg, height 105 cm
  – (19.59 kg x 18 kg) + (1.303 x ht) + 414.9
  – 353 + 137 + 414.9
  = 905 kcals/day x 1.3-1.5 = 1177-1358 kcals/day

Awesome!
Calculating Catch-Up Growth Energy Needs

- IBW in kg × DRI for age
  actual weight
  = A kcal/kg/d catch-up growth needs

- May use this equation for catch-up protein needs as well.

- IBW = 50% percentile weight for height or Weight corresponding to 50th percentile BMI/age.
Let’s Practice

• Using the DRI table and growth chart calculate the catch-up energy needs of 14month old girl: Weight is 7.8kg and height is 76 cm

• IBW in kg **9.2 kg** X DRI for age **82 kcal/kg/day**
  
  actual weight **7.8 kg**

  = **96 kcal/kg/d catch-up growth needs**
Assessment of Protein Needs

- Use DRI
- For the critically ill population, use ASPEN Guidelines

<table>
<thead>
<tr>
<th>Age</th>
<th>Protein Recommendations</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-2 years</td>
<td>2-3 g/kg/d</td>
</tr>
<tr>
<td>2-13 years</td>
<td>1.5-2 g/kg/d</td>
</tr>
<tr>
<td>13-18 years</td>
<td>1.5 g/kg/d</td>
</tr>
</tbody>
</table>
More Practice!

- Using your DRI table, estimate protein needs for a 13 month old girl, weighing 12 kg
  - \(1.08/\text{gm/kg/day} \times 12 \text{ kg} = 12.96 \text{ gm protein/day}\)

- Calculate protein needs for a 5 year old boy who is post operative. His weight is 18 kg
  - \(18 \text{ kg} \times 1.5-2 \text{ gm/kg/day} = 27-36 \text{ gm PRO/day}\)
Calculating Fluid Requirements

Two Methods

1. Holliday-Segar Method

<table>
<thead>
<tr>
<th>Weight in kg</th>
<th>Fluid Needs</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-10 kg</td>
<td>100 ml/kg</td>
</tr>
<tr>
<td>11-20 kg</td>
<td>1000 ml + 50 ml/kg for each kg &gt;10 kg</td>
</tr>
<tr>
<td>&gt;20 kg</td>
<td>1500 ml + 20 ml/kg for each kg &gt;20 kg</td>
</tr>
</tbody>
</table>
2. Body Surface Area (BSA) Mosteller Method

- BSA X 1500 - 200cc

- Calculate BSA:

\[
\sqrt{\frac{\text{Height (cm)} \times \text{Weight (kg)}}{3600}}
\]
Let’s Practice

Calculate the fluid needs of a healthy boy who is 6 years of age, he weighs 29 kg and his height is 125 cm

- 10 kg x 100 ml/kg = 1000 ml
- + 10 kg x 50 ml/kg = 500 ml
- + 9 kg x 20 ml/kg = 180 ml

Total = 1680 ml/day

Shortcut: (29-20 kg) x 20 ml/kg + 1500 ml = 1680 ml/day

Body Weight: 53 kg, height: 105 cm
Let’s Practice

- Calculate the fluid needs of a 15 year old boy who is in the hospital and uses a ventilator for respirator support. He weighs 53kg and is 155 cm tall.

BSA = \frac{53\text{kg} \times 155\text{cm}}{3600} = 2.28 \text{m}^2

\text{Squareroot of 2.28} = 1.5

\text{Fluid needs} = 1.5 \times 1500 - 2000\text{cc} = 2250 - 3000\text{cc}
Calculating Energy and Protein Intake

- Baby Henry was started on nasogastric tube feeds (NGT feeds)
- He was started on 24 kcal/oz formula, 2.1 gm protein /100 kcal
- His feeding regimen is 65 ml q3 hours

How many kcals and protein does this provide?
Let’s Practice

• Step 1: Calculate total volume provided in 24 hour period
  – 65 ml x 8 feeds = 520 ml/24 hours

• Step 2: Convert ml to ounces
  – 520 ml/30 ml/1 ounce = 17.33 oz/24 hours

• Step 3: Multiply caloric density of formula by total ounces
  – 17.33 oz x 24 kcal/oz = 416 kcals/day OR 119 kcals/kg/day

• Step 4: To figure out protein divide total kcals by 100 kcals
  – 416 kcals/100 kcals = 4.16
  – 4.16 x 2.1 = 8.7 gm/day OR 2.5 gm/kg/day
Fortification of Expressed Breast Milk

<table>
<thead>
<tr>
<th>Formula</th>
<th>Caloric Density (kcal/g)</th>
<th>Displacement (ml/g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enfamil Enfacare Powder</td>
<td>4.9 kcal/g</td>
<td>0.76ml/g</td>
</tr>
</tbody>
</table>

- Breast Milk = 20 kcal/ounce
  - 1 ounce = 30 ml
Breast Milk Fortification

- Calculate a recipe to fortify breastmilk to 24kcal/oz for an infant who needs to receive 456 ml of 24kcal/oz breastmilk @ 19cc/hr X 24 hours

- Determine amount of volume needed: 4 hours worth of feeds: 76 ml (~2.53 oz)

- Determine kcal/ounce needed from formula: 4 kcal/ounce

- Determine Total kcals needed from formula: 4 kcal/ounce X 2.53 ounces = 10.1 kcals
Breastmilk Fortification

• Find grams of formula by dividing: Total kcals of formula/ caloric density of formula:
  10.1 kcals / 4.9 kcal/g = 2.07 grams formula

• Determine the volume of powder displacement:
  grams of formula X displacement ml/g:
  2.07 grams X 0.76 ml/gram = 1.57 ml displaced
Steps in Breast Milk Fortification

• Take the final desired volume 76 ml - displaced volume 1.57 ml to determine amount of breast milk to use in recipe:
  ~74 ml EBM

• Now you have your recipe: grams of powder formula + ml of EBM = final volume desired at 24 kcal/ounce
  2.07 g Enfacare+ 74 ml EBM = ~76 ml of Enfacare + EBM at 24 kcal/ounce
FORMULA FORTIFICATION

- Formula Factors for Enfamil Premium 27 kcal/oz formula

<table>
<thead>
<tr>
<th></th>
<th>Caloric Density</th>
<th>Displacement</th>
<th>Multiplication</th>
<th>factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Formula</td>
<td>Kcal/gm</td>
<td>cc/1 gm of powder</td>
<td>Formula</td>
<td>Water</td>
</tr>
<tr>
<td>Enfamil Premium</td>
<td>5</td>
<td>0.76</td>
<td>0.180</td>
<td>0.863</td>
</tr>
</tbody>
</table>
FORMULA FORTIFICATION

• Determine how many oz and cc of formula you need to prepare:
  4oz OR 4oz x 30 cc = 120 cc

• Determine how many calories you need in your final volume:
  4 oz X 27 kcal/oz = 108 kcal

• Determine how much Formula powder you will need to prepare the recipe:
  Total kcal 108/5 Kcal/gm of powder = 21.6 gm of powder.
FORMULA FORTIFICATION

- Figure out how much water the powder will displace:
  \[
  21.6 \text{ gm of powder} \times 0.76 \text{ cc displaced/gm of powder} = 16.416 \text{ cc displaced}
  \]

- Calculate how much total water you need to prepare the recipe:
  \[
  120 \text{ total cc} - 16.416 \text{ cc displaced} = 103.58 \text{ total cc required}
  \]

- Write the raw recipe:
  Mix 103.6 cc of water with 21.6 gm of powder to prepare 120 cc of formula.
FORMULA FORTIFICATION

• Make the recipe user-friendly by converting grams into scoops or cups of powder required.

  22 gm of powder / gm/scoop OR gm/ cup = 2.5 scoops.

  **Round off the cc of water to closest whole number.

FINAL RECIPE

Mix 105cc of water with 2.5 scoops or 22 gm of powdered formula to prepare 120cc of 27kcal/oz Enfamil Premium formula.
Thank you...