Nutritional Assessment of the Critically Ill Patient
Terry L. Forrette, M.H.S., RRT

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Metabolic Rate
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“Fast unto Death”

How Much Fuel Does the Patient Need?

Resting Energy Expenditure
Basal Energy Expenditure
REE or EE
BEE

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Metabolic Rate

<table>
<thead>
<tr>
<th>Injury and infection</th>
</tr>
</thead>
<tbody>
<tr>
<td>Third degree burns</td>
</tr>
<tr>
<td>&gt; 20% BSA</td>
</tr>
<tr>
<td>Gastrointestinal</td>
</tr>
<tr>
<td>Multiple fractures</td>
</tr>
<tr>
<td>Prostatectomy</td>
</tr>
<tr>
<td>Partial starvation</td>
</tr>
</tbody>
</table>

Resting

Energy Sources

- Fat "Lipids" 120 g/D
- Carbohydrates "CHO" 300 g/D
- Proteins "Pro" 72 g/D

In

- Lipids 140,000 Kcal
- CHO 1200 Kcal
- Protein 52,000 Kcal

Out

- Total: 1100 Kcal
- Fat: 120 Kcal
- CHO: 300 Kcal
- Protein: 72 Kcal

70 kg 'normal' individual

1 Kcal = 1000 calories
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What's in your tank?

Substrate Utilization

The Respiratory Quotient (RQ) Spectrum

\[ RQ = \frac{VCO_2}{VO_2} \]

What's the cost?
How much oxygen is consumed …
carbon dioxide produced…
to maintain metabolism?

The Cost of Metabolism

Balanced

\[ \frac{\text{CO}_2}{\text{VO}_2} \]

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Mind what you have learned. Save you it can.

Metabolic rate
How Much

Energy Sources
What Type

Substrate Utilization
The Cost

Don’t Make it Too Complicated

Triad of Nutritional Assessment

Predictive Equations
Biochemical Indices
Calorimetry

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**Measured versus Predicted EE**

*Foster et al., Metabolism 37(5) 467-472, 1988.*

<table>
<thead>
<tr>
<th>Subjects of Same Height and Weight</th>
<th>Predicted</th>
<th>Actual</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>1724</td>
<td>1263</td>
</tr>
<tr>
<td>B</td>
<td>1740</td>
<td>1523</td>
</tr>
<tr>
<td>C</td>
<td>1743</td>
<td>1778</td>
</tr>
<tr>
<td>D</td>
<td>1744</td>
<td>1979</td>
</tr>
<tr>
<td>E</td>
<td>1743</td>
<td>2252</td>
</tr>
</tbody>
</table>

**The History of Indirect Calorimetry**

**Popular ICU Systems**

**The Basics of IC Measurements**

\[
\text{CO}_2 \text{ inspired} = VCO_2 + FICO_2 (VE) - FICO_2 (VI)
\]

\[
\text{O}_2 \text{ inspired} = VO_2 + FIO_2 (VI) - FEO_2 (VE)
\]
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Weir Equation

Steady-State Conditions
Cellular = Exhaled CO₂

RQ
cellular

RER
exhaled

Things that effect CO₂ Elimination
Circulation
Diffusion
Ventilation

Case Study
A 53 ♀ post-op 5 days following a AAA. The patient was conscious and responding to commands while breathing spontaneously between ventilator breaths.

Data Collected

<table>
<thead>
<tr>
<th>Data Collected</th>
<th>5 min</th>
<th>10 min</th>
<th>15 min</th>
<th>20 min</th>
<th>30 min</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ventilation (L/min)</td>
<td>12.2</td>
<td>15.7</td>
<td>8.6</td>
<td>14.3</td>
<td>16.7</td>
</tr>
<tr>
<td>RQ</td>
<td>0.98</td>
<td>1.26</td>
<td>0.76</td>
<td>1.11</td>
<td>1.28</td>
</tr>
<tr>
<td>REE (kcal/24 hr)</td>
<td>2245</td>
<td>1824</td>
<td>1402</td>
<td>2600</td>
<td>2075</td>
</tr>
</tbody>
</table>

... and some problems have no remedy
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Case Study 1

Insufficient calories

75 yo ♂ Dx with H1N1 flu. BMI was 30% of predicted with evidence of muscle catabolism.
Temp 38.2, HR 115, BP 147/98

TCI Pred EE RQ IC EE
?? 1650 .73 2130

The patient was started on feedings via NGT at 2200Kcal.

TCI Pred EE RQ IC EE 2200 1650 85 2130

Case Study 2

Excessive CHO calories

Ms RP, hx COPD, admitted to MICU with AVF requiring ventilatory support. IC on day 3.

TCI CHO/Fat EE RQ
2100 60:40 1950 1.04

Unable to wean due to high V̇e requirements to maintain PaCO2. IC study 18 hours after diet change.

TCI CHO/Fat EE RQ
2100 45:55 1640 .85

Case Study 3

Ventilator Management

Ms RP, hx COPD, admitted to MICU with AVF requiring ventilatory support. IC on day 3.

TCI CHO/Fat EE RQ
2100 60:40 1950 1.04

Unable to wean due to high V̇e requirements to maintain PaCO2. IC study 18 hours after diet change.

TCI CHO/Fat EE RQ
2100 45:55 1640 .85
Case Study

Mr. KS requiring high $V_{E}$ to maintain $\text{PaCO}_2$. Gas exchange studies were performed to determine increased $V_{D}$ or $\text{VCO}_2$. (TCI 2110 kcal)

<table>
<thead>
<tr>
<th>PEEP</th>
<th>EE</th>
<th>RQ</th>
<th>$V_{E}$</th>
<th>$V_{D}/V_{T}$</th>
<th>Cl</th>
</tr>
</thead>
<tbody>
<tr>
<td>12</td>
<td>2250</td>
<td>.86</td>
<td>18.2</td>
<td>.71</td>
<td>1.9</td>
</tr>
<tr>
<td>8</td>
<td>1923</td>
<td>.82</td>
<td>12.3</td>
<td>.56</td>
<td>2.3</td>
</tr>
</tbody>
</table>

Comments: IC studies were useful to R/O excessive CHO feedings and measure $V_{D}$ which was increased secondary to excessive PEEP levels.

Naysayers - Objections - Prejudices

Thank You