The resting energy expenditure and utilization of nutritive substrates in polytrauma patients in the ICU

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Rationale

Indirect calorimetry (IC) is the gold standard for measuring resting energy expenditure (REE) in the critically ill patient. REE determination is of high relevance to avoid both overfeeding and underfeeding, both of which increase morbidity and mortality rate. Multiple traumas cause an increase in plasma concentrations of pro-inflammatory cytokines, regulatory cytokines and cortisol and a decrease in concentration of anti-inflammatory cytokines. These changes lead to increased metabolic rate, protein catabolism and vascular permeability with edema. The aim of this study was to determine the resting energy expenditure and utilization of nutritive substrates (UNS) in polytrauma patients compared with healthy volunteers that is not well known.

Study design

This single-center pilot study was performed on 16 polytrauma patients (PP) (14 men and 2 women) with mean age 38.6±16.3 years and compare with 24 healthy subjects (HS) (10 men and 14 women) with mean age 36.7±15.7 years, both was obtained after 12 hours of fasting prior to assessment. PP were spontaneously breathing in the intensive care unit, and all had high mean APACHE II and ISS scores. The study was reviewed and approved by the Ethical Committee of Charles University, Faculty of Medicine in Hradec Králové and all subjects gave written informed consent.

Statistical analysis

The acquired data were analyzed using programs Graph-Pad Prism6 (GraphPad Software, La Jolla, CA, USA) and Excel 2013 (Microsoft, Redmont, WA, USA). All parameters were evaluated by descriptive statistics. Values are expressed as mean ± SD. Statistically significant differences between parameters were evaluated by the Student t test.

Results

<table>
<thead>
<tr>
<th></th>
<th>PP (n = 16)</th>
<th>HS (n = 24)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age [years]</td>
<td>38.6 ± 16.4</td>
<td>36.2 ± 16.4</td>
</tr>
<tr>
<td>Height [m]</td>
<td>177.9 ± 9.2</td>
<td>174.6 ± 7.4</td>
</tr>
<tr>
<td>Body weight [kg]</td>
<td>88.5 ± 19.4 *</td>
<td>72.0 ± 16.2</td>
</tr>
<tr>
<td>BMI [kg/m²]</td>
<td>27.9 ± 7.5 *</td>
<td>23.5 ± 4.3</td>
</tr>
<tr>
<td>Length of ICU stay [d]</td>
<td>9.0 ± 9.9</td>
<td>-</td>
</tr>
<tr>
<td>BSA [m²]</td>
<td>2.1 ± 0.2</td>
<td>1.9 ± 0.2</td>
</tr>
<tr>
<td>UN [g/d]</td>
<td>30.0 ± 13.0 *</td>
<td>14.4 ± 5.4</td>
</tr>
<tr>
<td>ISS score</td>
<td>28.0 ± 9.2</td>
<td>-</td>
</tr>
<tr>
<td>APACHE II score</td>
<td>9.6 ± 6.3</td>
<td>-</td>
</tr>
</tbody>
</table>

Table 1. Demographic and descriptive characteristics of the patients
Values given are the mean ± SD; * — statistically significant difference between PP and HS (P<0.05)

Abbreviations: BMI — body mass index; BSA — body surface area; UN — urine nitrogen excretion;

<table>
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<tr>
<th></th>
<th>PP (n = 16)</th>
<th>HS (n = 24)</th>
</tr>
</thead>
<tbody>
<tr>
<td>VO₂ [l/min]</td>
<td>0.36 ± 0.08 *</td>
<td>0.25 ± 0.05</td>
</tr>
<tr>
<td>VCO₂ [l/min]</td>
<td>0.25 ± 0.06 *</td>
<td>0.19 ± 0.05</td>
</tr>
<tr>
<td>RQ</td>
<td>0.70 ± 0.08*</td>
<td>0.76 ± 0.06</td>
</tr>
<tr>
<td>NRQ</td>
<td>0.67 ± 0.16*</td>
<td>0.72 ± 0.13</td>
</tr>
<tr>
<td>REE [kcal/d]</td>
<td>2,394 ± 554 *</td>
<td>1,695 ± 338</td>
</tr>
<tr>
<td>BMR [kcal/d]</td>
<td>1,935 ± 256 *</td>
<td>1,634 ± 228</td>
</tr>
<tr>
<td>REE/BMR [%]</td>
<td>123 ± 26 *</td>
<td>106 ± 12</td>
</tr>
<tr>
<td>REE/W [kcal/kg/d]</td>
<td>27.1 ± 7.7</td>
<td>23.5 ± 3.3</td>
</tr>
<tr>
<td>REE/BSA [kcal/m²/d]</td>
<td>1,140 ± 256 *</td>
<td>914 ± 108</td>
</tr>
</tbody>
</table>

Table 2. Parameters from indirect calorimetry measurements: 2A—Energy expenditure; 2B—Nutrition substrate utilization
Values given are the mean ± SD; * — statistical significance difference between PP and HS (P<0.05)

Abbreviations: VO₂ [l/min]— oxygen consumption; VCO₂ [l/min]— carbon dioxide expiration; RQ— respiratory quotient; NRQ— non-protein respiratory quotient; REE— resting energy expenditure; BMR— basal metabolic rate predicted via Harris-Benedict equation; REE/BMR [%] — % energy expenditure of Harris-Benedict equation; REE/W — energy expenditure per kg body weight; REE/BSA— energy expenditure per m² body surface area; TCEE — total caloric energy expenditure

Patient REE was as expected significantly higher than that of the control group, corresponding to the hypermetabolism, typical for polytrauma patients. 68.6% of PP were in a hypermetabolic state (29.2% in HS), 25.0% were in a normometabolic state (58.3% in HS), and 6.3% were in a hypometabolic state (12.5% in CG).

PP had higher REE expressed in kcal/d compared with HS (1,935.0±256.0 kcal/d vs. 1,634.0±228.0 kcal/d; P<0.01), but both groups had similar REE expressed per kg body weight: PP 27.1±7.7 kcal/kg/d; and HS 23.5±3.3 kcal/kg/d (P=0.30).

PP had higher utilization of protein (2.1±1.0 g/kg/d vs. 1.2±1.6 g/kg/d; P<0.01), similar carbohydrate (1.5±1.2 g/kg/d vs. 1.2±1.6 g/kg/d; P=0.62) and lipid utilization (1.6±0.6 g/kg/d vs. 1.5±0.5 g/kg/d; P=0.70) compared with healthy subjects.

Conclusion

REE expressed in 27 kcal/kg/d in PP was similar to that in healthy individuals. Precisely measured body weight was demonstrated as determinant of REE and UNS in PP. Protein oxidation in PP was increased in 2 g/kg/d relative to healthy subjects. Validation study will follow to demonstrate that fact, which could then be applied in clinical practice for predicting REE.