# Complex predictive formulae are superior to kcal/kg in estimating energy needs of critically ill patients

**FOR:**

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*Intensive Care Med*
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RESEARCH AGENDA

# The intensive care medicine research agenda in nutrition and metabolism

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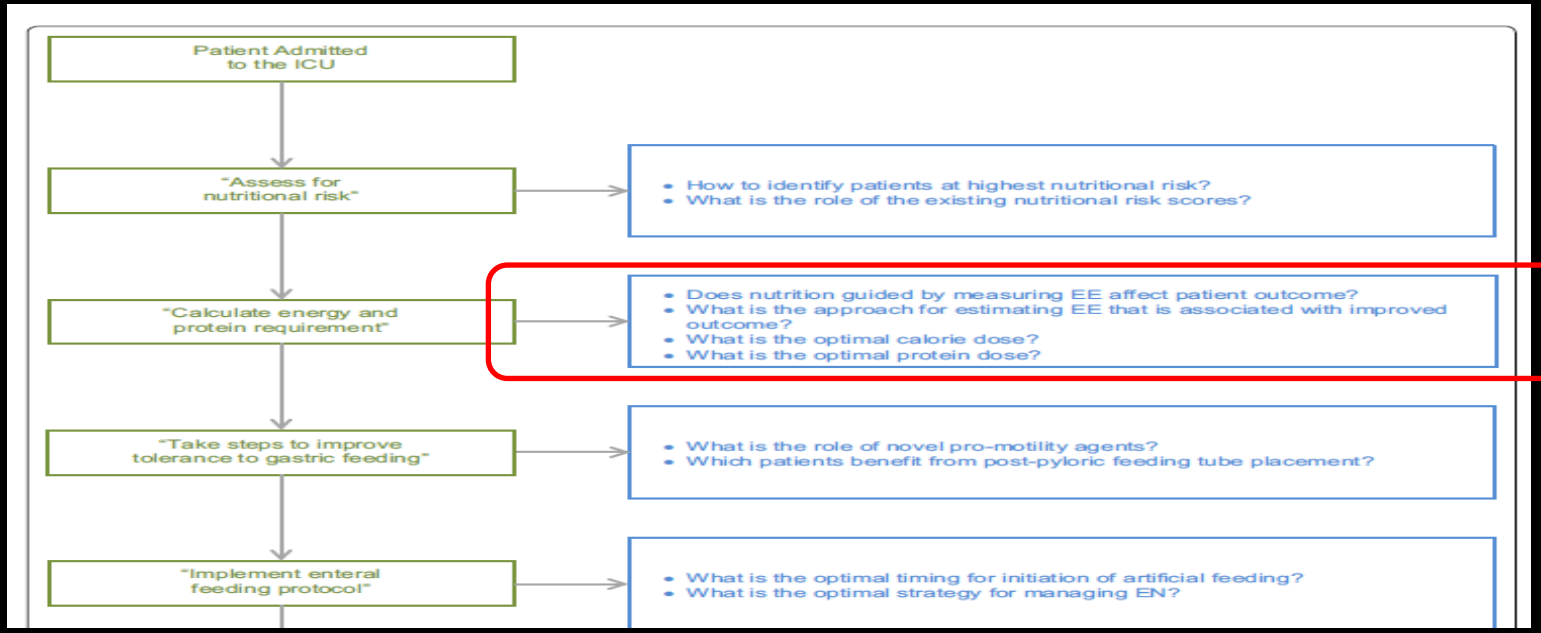
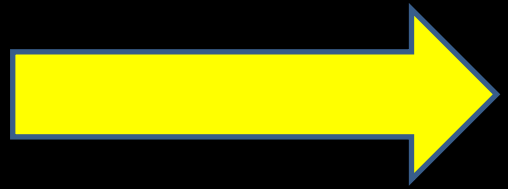


# Factors influencing EE

- ✓ Age
- ✓ Sex
- ✓ Height
- ✓ Muscle mass
- ✓ Disease
- ✓ Illness severity
- ✓ Surgery
- ✓ Sedation
- ✓ Paralysing agents
- ✓ Temperature
- ✓ Ventilator settings
- ✓ Physical activity
- ✓ Pain



Want a predictive equation to take these in to consideration

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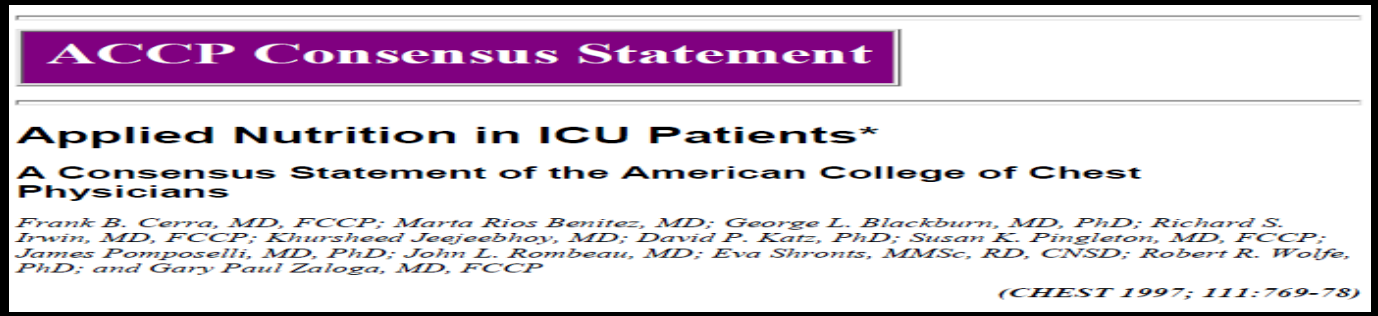
Opinion paper

# Pragmatic approach to nutrition in the ICU: Expert opinion regarding which calorie protein target

Pierre Singer [a,*], Michael Hiesmayr [b], Gianni Biolo [c], Thomas W. Felbinger [d], Mette M. Berger [e], Christiane Goeters [f], Jens Kondrup [g], Christian Wunder [h], Claude Pichard [i]

*It is necessary to identify safe, minimal and maximal amounts for the different nutrients and at the different stages of acute illness to avoid under & overfeeding. These amounts might be specific for the different phases in the time course of a disease*

# Where does 25kcal/kg come from?



ACCP Consensus Statement

**Applied Nutrition in ICU Patients***

**A Consensus Statement of the American College of Chest Physicians**

*Frank B. Cerra, MD, FCCP; Marta Rios Benitez, MD; George L. Blackburn, MD, PhD; Richard S. Irwin, MD, FCCP; Khursheed Jeejeebhoy, MD; David P. Katz, PhD; Susan K. Pingleton, MD, FCCP; James Pomposelli, MD, PhD; John L. Rombeau, MD; Eva Shronts, MMSc, RD, CNSD; Robert R. Wolfe, PhD; and Gary Paul Zaloga, MD, FCCP*

*(CHEST 1997; 111:769-78)*

*(1) Total Calories:* The existing body cell mass is a major determinant of the total caloric requirement. The total caloric requirement can either be estimated or directly measured. Whether precisely matching energy input with energy expenditure improves patient outcomes remains controversial. Calorie overload should be avoided, but energy should be administered to promote anabolic functions. Administering 25 total kilocalories per kilogram usual body weight per day (1 kg/d) appears to be adequate for most patients. The total calories should be administered in a volume consistent with the total fluid needs of the patient. In general, 1 mL of water is needed per kilocalorie administered.

# Criticisms of kcal/kg

| | |
|---|---|
| Origins unknown | • Rule of thumb<br>• Unsure how & when originally derived<br>• Can't know what population it was derived from |
| Aimed for 'most patients' | • What does this mean / include?<br>• What weight should you use? Actual vs. Ideal vs. adjusted?<br>• What about extremes of weight & age? |
| Variation of EE | • Doesn't consider variation of EE over time<br>• Between different patient types |
| Accuracy | • has poor prediction accuracy<br>• May lead to underfeeding or overfeeding |

# Complex predictive equations

# Equation Validations

| Equation | Year Developed | Population | Sample size |
|---|---|---|---|
| ***Harris & Benedict*** | 1919 | Healthy | 239 |
| ***Schofield*** | 1985 | Healthy, mostly physically active Italian males | 114 |
| ***Mifflin-St Jeor*** | 1989 | Healthy, larger proportion of obese than the above. | 498 |
| ***Swinamer*** | 1990 | Sepsis and trauma | 112 |
| ***Ireton-Jones*** | 1992 | Trauma and burns | 65 |
| ***Frankenfield*** | 1994 | Trauma | 46 |
| ***Ireton-Jones*** | 1997 | Trauma and burns | 99 |
| ***ACCP*** | 1997 | Unknown, no reference | Unknown, no reference |
| ***Penn State*** | 1998 | Trauma, surgical and medical | 169 |
| ***Penn State*** | 2003 | Trauma, surgical and medical | 47 |
| ***Faisy*** | 2003 | Medical | 70 |

# Penn State (PSU)

| PSU / Mifflin (M) (Frankenfield 2003) |
| --- |
| Mifflin:<br>Men; 10 x wt (kg) + 6.25 x ht (cm) – 5 x age + 5<br>Women: 10 x wt (kg) + 6.25 x hg (cm) – 5 x age – 161<br><br>PSU (M)<br>Mifflin x 0.96 + T max x 167 + Ve x 31 – 6212<br><br>T max – max T in degrees C over last 24hrs<br>Ve – minute ventilation – at time of assessment |
| PSU (M)- > BMI 30 and > 60yrs (Frankenfield 2011) |
| Mifflin x 0.71 + T max x 85 + Ve x 64 – 3085 |

***What weight to use?***

The metabolic rate equations were developed with a mix of obese and non- obese individuals, and actual body weight was used to calculate the equation. Therefore, despite the distortion that obesity causes in the relationships between fat-free mass and body weight, as well as between muscle mass and organ mass, actual body weight of the person should be used in the existing equations for predicting resting metabolic rate.

Original Communication

# Analysis of Estimation Methods for Resting Metabolic Rate in Critically Ill Adults

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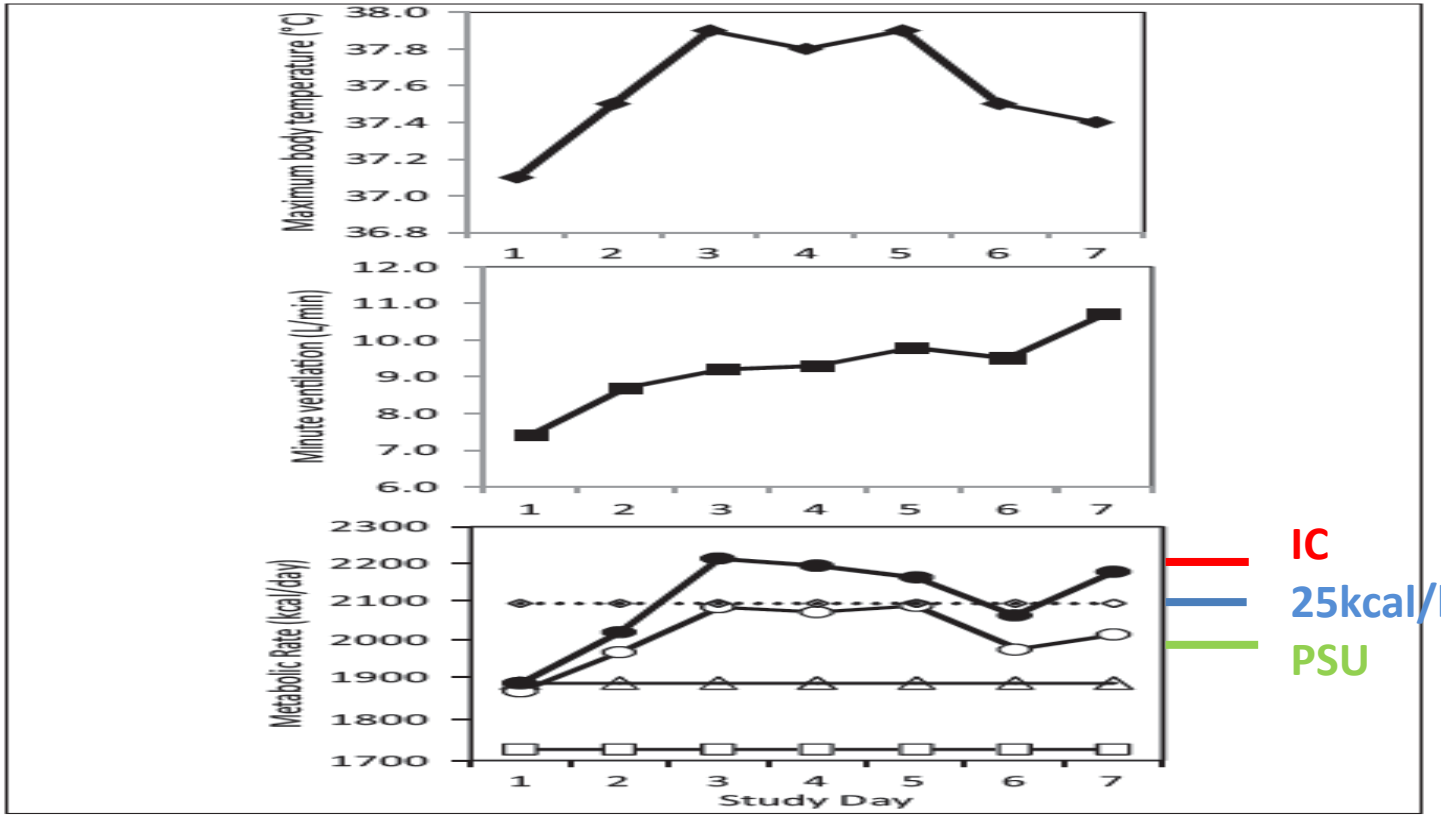
Table 6. Accuracy Rates of the Equations (Percentage of Estimates ≤10% Different From Measured)

| Equation | All | Young Nonobese | Young Obese | Elderly Nonobese | Elderly Obese |
|---|---|---|---|---|---|
| HBE | 34[b] | 31[b] | 45[b] | 27[b] | 35[b] |
| HBE × 1.25 | 46[b] | 50[b] | 45[b] | 56[b] | 33[b] |
| HBEa(25) | 18[b] | 31[b] | 0[b] | 27[b] | 12[b] |
| HBEa(25) × 1.25 | 52[b] | 50[b] | 62 | 56[b] | 33[b] |
| HBEa(50) | 22[b] | 31[b] | 9 | 27[b] | 22[b] |
| HBEa(50) × 1.25 | 53[b] | 50[b] | 66 | 56[b] | 43 |
| Mifflin | 25[b] | 23[b] | 21[b] | 21[b] | 35[b] |
| Mifflin × 1.25 | 49[b] | 54 | 53[b] | 54[b] | 43 |
| ACCP (wt) | 35[b] | 44[b] | 34[b] | 50[b] | 12[b] |
| ACCP (MAW) | 46[b] | 44[b] | 47[b] | 50[b] | 43 |
| Swinamer | 54[b] | 61 | 51 | 60 | 43 |
| Ireton-Jones | 46[b] | 33[b] | 49[b] | 50[b] | 51 |
| PSU(HBE) | 64 | 65 | 66 | 77 | 46 |
| PSU(HBEa) | 62 | 58 | 70 | 62 | 59[a] |
| PSU(m) | 67[a] | 69[a] | 70 | 77[a] | 53 |
| Brandi | 55[b] | 61 | 55 | 61 | 41 |
| Faisy | 53[b] | 65 | 72[a] | 37[b] | 39[b] |

[a]Best equation in subgroup. All statistical comparisons are to this equation.
[b]$P < .05$ compared with best equation in the subgroup.

# How does PSU vs. 25kcal/kg measure against IC over 7 days?




Frankenfield D- JPEN 2013

# Conclusion

- ✓ All predictive equations have an element of inaccuracy compared to IC
- ✓ But, the PSU equation appears to be more precise than kcal/kg
- ✓ PSU is designed to be used in mixture of ICU patients, including obese & elderly
- ✓ It makes you think of impact of clinical parameters
- ✓ Use it to help you track EE over the duration of critical illness