

Changes in ¹³C/¹²C Delta Value in Exhaled Breath in Parenterally-Fed Patients

Caitlin Curtis, PharmD¹, Daniel Butz, PhD², Emily Breunig, CPM,² Glen Leverson, PhD,³ Kenneth Kudsk, MD^{3,4}

1. Pharmacy, University of Wisconsin Health 2. Isomark, LLC 3. Surgery, University of Wisconsin School of Medicine and Public Health 4. Surgery, Veterans Administration Surgical Service, William S Middleton Memorial Veterans Hospital

Background

Determining energy during parenteral nutrition (PN) is challenging, especially in patients with large wounds, missing limbs, burns, or BMI greater than 30 mg/kg.² While metabolic cart measurements are the current “gold standard” for estimating energy needs, the method is costly, not always available, and may be unreliable with chest tubes or when receiving continuous renal replacement therapy.

Carbon-12 (¹²C) & ¹³C are natural isotopes measurable by cavity ring-down spectroscopy. Converting glucose to fat incorporates less ¹³C than ¹²C reducing the fat ¹³C/¹²C ratio. As fat burns, the ¹³C/¹²C drops as less ¹³C is released. This is measurable via exhaled breath delta (BDVs) via the equation, with Pee Dee Belemnite (PDB) as standard:

$$\delta = \frac{{}^{13}\text{C}/{}^{12}\text{C sample} - {}^{13}\text{C}/{}^{12}\text{C PDB}}{{}^{13}\text{C}/{}^{12}\text{C PDB}} \times 1000$$

A high calorie diet fed to subjects after prior calorie restriction increases the BDV as less fat is burned.

Hospitalized patients fed parenteral nutrition (PN) after a period of starvation mimic this pattern of negative to positive-energy balance provide an opportunity to study exhaled ¹³C/¹²C breath delta values (BDVs) and assessment of metabolic changes with refeeding for usefulness as a method to determine appropriate levels of nutrition support.

Objectives

To define:

- Baseline variations in BDV in patients requiring PN
- Temporal changes in BDV from PN initiation to goal rate
- The effect of PN interruption on BDV measurement.

Hypotheses:

- 1) BDV will increase (become less negative) as TPN is advanced on proportion to the amount of calories administered.
- 2) If PN is interrupted, BDV will reverse (become more negative)

Methods

IRB approval for a study of 20 adult patients expected to need PN for ≥5 days & continued maximum of 7 days or until PN stopped. All PN given per Nutrition Support Team protocol. Patients were excluded if receiving PN prior to admission. Exhaled 400mL breath samples were collected daily at the same time (+/- 1 hour) as baseline & BDV measured with the Isomark Canary™ device.

Statistics: BDVs analyzed using a linear mixed model with subject-specific random effects. 20 subjects were consented.

Results

Of the 20 patients: 14 completed 7 days
3 completed 6 days
1 completed 5 days
2 completed 4 days

8 samples were lost due to technical issues and treated as missing. Final *n* for analysis is listed on Figure 1.

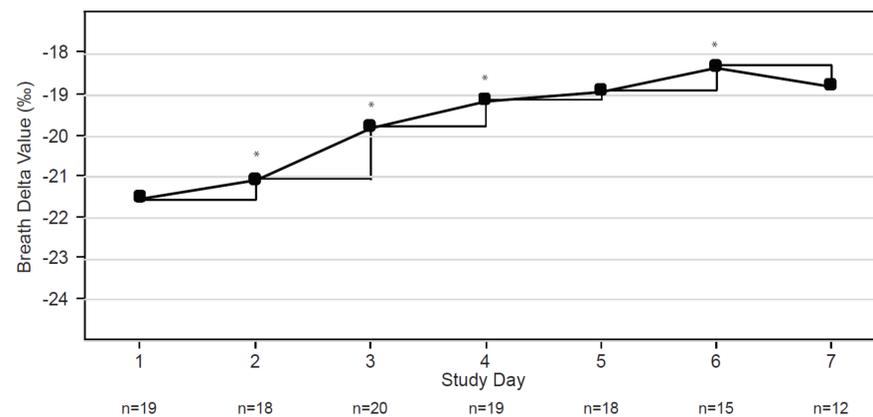


Figure 1

BDV increased (became less negative) as PN calories increased with the following significant changes (Fig1):

- * Day 1 vs 2, Δ BDV 0.63 ± 0.97, p=0.0063
- * Day 2 vs 3, Δ BDV 1.28 ± 0.78, p=<0.0001
- * Day 3 vs 4, Δ BDV 0.60 ± 1, p=0.0062
- * Day 5 and 6, Δ BDV 0.36 ± 1.68, p=0.0012

Results

Five subjects had PN stopped with samples collected the next day and BDV dropped significantly (-2.42 ± 1.76, p=0.03)

A significant relation exists between kcal administered and BDV change. For every unit increase in kcal/kg/hr, BDV increases by 2.8 (p<.00001). See Figure 2.

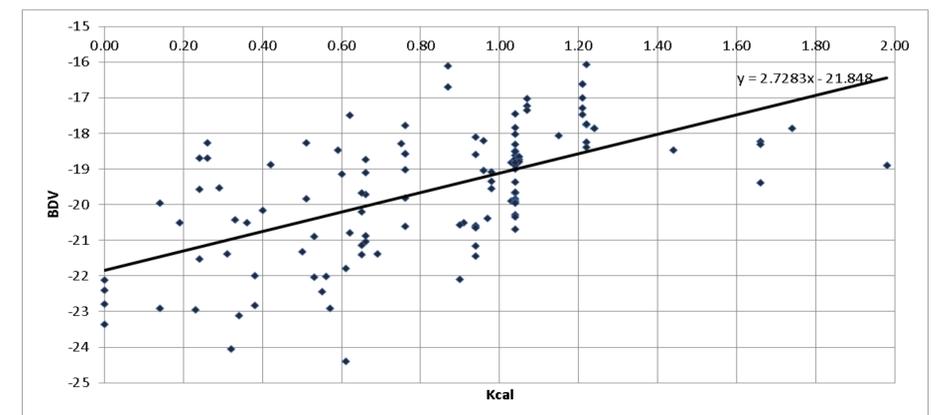


Figure 2

Discussion

BDV increased as PN was administered to previously unfed hospitalized patients reflecting the changes in fat metabolism as unfed patients receive exogenous calories. BDV changes correlate with the amount of kcal provided in the PN.

Conclusions

BDV measurement by sequential respiratory sampling is sensitive to metabolic changes induced by PN administration. BDV significantly increases as PN calories are provided to previously unfed hospitalized patients. Conversely, BDV decreases if PN is interrupted. Further study will determine if BDV is a sensitive, useful tool to define an adequate, if not the optimal, energy prescription for hospitalized patients.

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