

Johns Hopkins Bayview Medical Center

GENERAL CLINICAL RESEARCH CENTER

Policy No: 159

Metabolic Cart Procedure

Original Date: April 10, 2003

Previous Date: None

Reviewed Date: None

Purpose: to provide operational procedures and policies for use of the Deltatrac Metabolic Cart

Policy:

1. The gases of the Metabolic Cart must be calibrated on each day of use. The date, time of calibration and the name of the person conducting the calibration are recorded on the Metabolic Cart log on the Metabolic cart.
2. If the machine cannot be calibrated; it is not to be used and will require an alcohol burn calibration. This is a specialized calibration method and should be conducted by Clinical Engineering or specially trained staff.
3. Do not use the Metabolic cart in the presence of flammable anesthetics
4. The sampling gas flow is about 150 ml/min for about 50% of the measurement cycle. In pediatric measurements this flow will need adjustments, please refer to operator's manual and obtain protocol specific orders
5. Constant participant monitoring is required while the metabolic rate is being assessed.

Definitions:

Resting Metabolic Rate (RMR) – energy expended for maintenance of normal body function with a small component related to sympathetic nervous system. RMR is affected by the participant's nutritional state, thyroid level, age, gender, body composition and genetic makeup.

Thermic Effect of Feeding (TEF) – energy expended above RMR after food consumption for absorption, metabolism and storage of food within the body. TEF is not affected by body composition. Components of TEF include:

Obligatory thermogenesis – energy cost associated with adsorption and transport of foods and the synthesis of protein, fat and carbohydrate required for both the constant renewal of body tissues and storage

Facultative thermogenesis – energy expended in excess of obligatory thermogenesis and appears to be partially mediated by the SNS and substrate cycling

Thermic Effect of Exercise (TEE) – energy above RMR and TEF due to physical activity including shivering and fidgeting. It can range from < 100 kcal/day for inactive individuals to >1,000 kcal/day for people who do strenuous exercise.

VCO₂ - Carbon Dioxide Production. This depends on metabolic tissues and substrate of energy metabolism for example, 1 kcal from carbohydrate produces 207 ml CO₂

1 kcal from fat produces 151 ml CO₂

1 kcal from protein produces 181 ml CO₂

VO₂ - Oxygen consumption. This depends on metabolic activities of tissues.

RQ – Respiratory Quotient $RQ = VCO_2 / VO_2$ This reflects mixture of substrates utilized by energy metabolism, for example RQ of carbohydrate = 1.0

RQ of fat = 0.7

RQ of protein = 0.81

Note: If $.65 < RQ < 1.0$ for 10-15 minutes of measurements, stop and re-calibrate the machine or if needed reschedule the test.. Usually, the fasting RQ values range from 0.7 – 0.87. In some

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protocols, eg when participants are asked to drink a nutritional supplement like Ensure, the RQ values should approach 1.0

EE – Energy Expenditure (kcal/day) This is calculated from the measured gas exchange variables and protein oxidation, for example RMR, TEF, TEE. Please note that the EE calculation after supplement consumption should be greater than the fasting EE calculation

Procedure:

Pre-Assessment of Participant:

The participant should be in a stable resting state at the time of metabolic measurements. Please note and refer to the Investigator or Research team for the following items:

1. Fasting state – the participant should have fasted for 12 hours. No food or beverages, except water. No consumption of anything with potential calories in allowed; this includes things items like breath mints or gum.
2. No excessive weight loss – Participants should not have lost more than 3 lbs in the past week regardless of cause, such as flu, illness or dietary/religious fasting
3. Avoidance of physical activity/exercise – The participant should avoid vigorous physical activity and exercise the day before and morning of the test. Light grooming is allowed on the morning of the test. Ideally, the participants should come to the research unit as close as possible to the time they usually awaken in the morning.
4. Comfortable room- The room should be a thermo-neutral environment (normal room temperature). Avoid testing in rooms that have inadequate heating or are too hot that would make the participant shiver, or sweat. Provide a blanket to make the participant as comfortable as possible.
5. Use bathroom before testing- Ask the participant to use the rest room prior to being placed in a bed for testing.
6. Rest in Bed- Have the participant rest in the bed for a minimum of 30 minutes prior to starting metabolic measurements. The participant can read during the resting period or watch television, but they may not do these activities during the metabolic measurement.
7. Good night's rest – Ideally, the participant should have at least 7 hours of sleep. If the participant was up for most of the night because of insomnia, coughing, cold or illness, please consult with the investigator as to the need to reschedule testing.
8. Inclined- The testing bed or chair should be semi-recumbent and not flat. It should be inclined at 10 degrees.
9. No huge meal the night before procedure- The evening meal the night prior to testing should not exceed 1000 kcals. This is usually not an issue, unless the participant had a special occasion or went to a buffet style restaurant and ate excessively. The participant should be advised to have a light meal the evening prior to testing.
10. Participant parameters: Assess and document participant
 - a. Height
 - b. Weight
 - c. Age

Johns Hopkins Bayview Medical Center

GENERAL CLINICAL RESEARCH CENTER

Policy No: 159

Metabolic Cart Procedure

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- d. Gender
- e. Time placed in bed
- f. Length of testing
- g. Time test started

Set up and Calibration Sequence

1. Warm Up

- a. Turn on Deltatrac Metabolic Cart at least 30 minutes prior to calibration. The cart can be left on overnight to ensure that it is warmed up for early morning testing. The power button is located on the back of the box in the upper left corner (as you face the back). If necessary, press the white button to silence the alarm for the warm up process.
- b. Make sure Printer is on.

2. Set Up: Check the Setup Screen by pushing the "Setup" Button. Screen should read:

- a. Delay: 5 minutes
- b. Data Pump to PC: Off
- c. Mode: Canopy
- d. Artifact Suppression: Off
- e. Averaging: Off
- f. Ventilation Alarm: Off
- g. Print Operation: Numerical

3. Monitor Mode: Press "Normal Screen" button to return to monitoring mode.

4. Calibration

- a. Calibrate the machine each morning by pressing the "Cal" button to display the Calibration menu.
- b. Select the "gas" in the calibration menu by pressing the number "1" button. The automatic baseline check will be done by device so that $O_2 = 95\%$ and $CO_2 = 5\%$, after which "Calibration Completed" message appears.
- c. Turn on the gas by moving the flat metal handle on the O_2/CO_2 tank (located at the back of the cart) forward [counterclockwise]. Gas pressure is adjusted to 50-60 psi (on left dial) by turning the middle plastic handle; Decrease = Counterclockwise, Increase = Clockwise.
- d. If calibration deviates from normal the following messages will appear:
 - i. Adjustment over 3% of O_2 . Please repeat calibration.
 - ii. Maximum adjustment for O_2 5%. Please repeat calibration. (Corresponding messages will appear for CO_2 .)
- e. Repeat calibration if necessary. Check calibration gas to see if bottle is empty or if bottle is tightly screwed into fitting. If message reappears, contact service personnel at 1-800-231-2466.
- f. **TURN GAS OFF!!**

5. Entering Patient Data (optional)

- a. Press "Patient Data" button to enter patient information such as
 - i. Gender

Johns Hopkins Bayview Medical Center

GENERAL CLINICAL RESEARCH CENTER

Policy No: 159

Metabolic Cart Procedure

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- ii. DOB
 - iii. Weight (“1” = increase lbs, “2” = decrease lbs)
 - iv. Height
 - v. N₂ excretion (which should not be changed because we do not use this)
 - vi. Age
 - vii. Basal Metabolic Rate (for Inpatients)/Resting Metabolic Rate (for Outpatients)
 - viii. Prediction Equations. Use Harrison-Benedict for normal weight patients. Use Fleisch or Reed Equations for overweight or apneic patients. Please note that the only reason to enter participant data is to obtain the Harrison-Benedict, Fleisch or Reed Equations. However, the equation of WEIR uses only VCO₂ and VO₂.
- b. To tab to the next variable, press “3”. To save data, press “4.” To return to monitor mode, press “Normal Screen.”

Participant Testing Procedure

1. Verify informed consent
2. Instruct participant on the procedure and what to expect. Discuss any concerns about claustrophobia. Instruct the participant that during the testing, they must avoid talking, fidgeting and sleeping. The participant can close their eyes, but have them avoid sleeping. Sleep can reduce the caloric expenditure by 10% as compared to the resting state.
3. Testing should be done while the participant is fasting or per research specific protocol orders.
4. The testing area should be quiet, dim lighting, neutral environment, and at a thermo-neutral temperature (67°-70°F).
5. Have patient lie at a 10° incline using 2-3 pillows and the incline on the bed.
6. Ask the patient the following questions:
 - a. Has he/she lost weight (>3 lbs)? (Pt should be weight stable.)
 - b. Is pt sick with flu, etc? (Answer should be No.)
 - c. When was their last meal? (Pt should have been fasting for 12 hours. No food, gum, breath mints. Water only.)
 - d. Did pt exercise last night/this morning? (Answer should be No.)
 - e. Any physical activity this morning? (Answer should be No.)
 - f. Have patient void before test.
7. Have patient lie in bed for a half hour prior to test (reading/watching TV OK) to keep heart rate low.
8. To begin test, place metabolic cart canopy over the head of the patient so that outlet with tubing to machine is close to mouth of patient and outlet with silver nozzle is at the top of the head. Fold the plastic flaps under the pillow and around patient to minimize air leakage. Attach thick tubing to front outlet if not already done so and attach thin plastic tubing to silver nozzle. Attach small “sample gas line” to appropriate nozzle on the ventilated hood.
9. Have patient lie still for 30-45 minutes.

Johns Hopkins Bayview Medical Center

GENERAL CLINICAL RESEARCH CENTER

Policy No: 159

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10. Press “Start/Stop” key to begin measurement. Obtain measurements for resting metabolics for 30 to 45 minutes. Extend the test if you don’t observe a 4-5 minutes time span with a <5-10% variance in O₂ and CO₂ readings, so that the patient has more time to relax and you get such a reading.
11. Write patient’s name on report printout once the test is begun.
12. Every 5-8 minutes, verify that the participant is tolerating the procedure well and to ensure that he/she is awake.
13. Metabolic Measurements
 - a. See attached sheet entitled “Metabolic Cart Demonstration” for explanation of measurements VO₂, VCO₂, RQ, and EE.
 - b. Determining validity of metabolic measurement: Look at VO₂ and VCO₂ results to find 4-5 consecutive minutes with little variability (<5-10%).
 - c. Take the average RQ and EE for those time points.
 - d. Average RQ for participants should be 0.75 to 0.80
 - e. If irregular breathing occurs or if the participant has sleep difficulties, the participant may never achieve a steady state resting metabolic rate. In this case, allow measurement time to reach 45 to 50 minutes. After 50 minutes, stop test and attempt to redo the test on another morning. When redoing test, attempt to provide additional pillows to ensure more forward flexion of the neck (with hopes of further opening of the airway.)
14. Ending Test
 - a. Press the “Start/Stop” button to end measurement. Press “Silence Alarm” button if needed.
 - b. Press “End” button at end of measurements.
 - c. Press “End Report” button (Button “1”) in END menu to print the measurement results.
15. New Patient
 - a. Press “End” again, then press “3” to clear, and press “1” for a new patient.

Cleaning Of Equipment:

Clean canopy and apparatus after each test using Clavcide or a diluted bleach solution. Clean the inside and outside of the tubing, the bottom of the tube on the canopy, and the inside of the canopy. Tag the equipment with the date of last cleaning. Verify with the calibration log that this was the last time the equipment was used. If you are unsure then clean the equipment prior to next use.

References:

Deltatra II Operator’s Manual from SensorMedics, 1994.

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GENERAL CLINICAL RESEARCH CENTER

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Franckowiak, SC, Forde, KM, Andersen, RE. *Metabolic Assessment of the Overweight Patient*. In CD Berdanier (ed.) Handbook of Nutrition & Food. Boca Raton, FL: CRC Press: 2002: 713-736.

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