ECAL(TM) is a new Indirect Calorimeter designed primarily for clinical use. ECAL is currently licensed for sale in Europe, The United Kingdom and Australia. Updated licence information can be obtained by contacting the company or visiting www.metabolichealthsolutions.com.au

“ECAL makes the science of obesity management more precise.”

Dr CM Khoo
Obesity Specialist,
Senior Endocrinologist,
National University Hospital, Singapore

ECAL(TM) is a new Indirect Calorimeter designed primarily for clinical use. ECAL is currently licensed for sale in Europe, The United Kingdom and Australia. Updated licence information can be obtained by contacting the company or visiting www.metabolichealthsolutions.com.au

All rights reserved
Copyright MHS 2016
OBESITY, METABOLISM AND ENERGY DISORDERS

OBESITY

Approximately 600 million adults are now obese, which is double 1980 levels - with another 1 billion overweight adults. Even among the young, obesity is increasing, with 43 million pre-school children overweight or obese in 2010. If nothing is done to reverse this growing pandemic, more than 2 billion adults will be obese by 2030.

Obesity significantly increases the risk of other diseases, including cardiovascular disease, type 2 diabetes, some cancers, as well as early death. For type 2 diabetes alone, the number of people afflicted worldwide will double in 2020 from the 2012 levels of 500 million persons.

METABOLISM

METABOLISM (or metabolic rate) is the rate of energy expenditure as determined by the sum total of the chemical reactions that occur in the human body for normal function. It determines how much energy is needed each day. This information is important to ascertain how much food should be consumed in order to maintain ENERGY BALANCE, the relationship between ENERGY INTAKE (food consumption) and ENERGY EXPENDITURE (resting metabolism + daily activities). Energy Balance is an important factor to achieve weight maintenance, the equilibrium between Energy Intake and Expenditure.

ENERGY DISORDERS

Mitochondrial and metabolic medical conditions are also known as energy diseases. These Energy Disorders actually include more than 40 different identified diseases that have different genetic features. The common factor among these diseases is that the mitochondria are unable to completely burn food and oxygen in order to generate energy. Energy disorders can be classified according to their primary cause namely,

Energy Surplus e.g. Obesity, Metabolic Syndrome, Insulin Resistance

Energy Deficit e.g. Prolonged Fatigue, Chronic Fatigue Syndrome, Anorexia

Energy Production e.g. Diabetes, Mitochondrial Dysfunction

The incidence of most types of energy disorders has increased significantly over the past 20 years in many countries of the world, particularly the developed countries. For example, obesity levels are reported to have more than doubled in Australia over this short time period. The AusDiab 2005 Australian Diabetes, Obesity and Lifestyle Study also revealed that the number of people with diabetes had more than doubled since 1981. Currently around 30% of general practice consultations relate to fatigue, often of a metabolic nature. Prolonged Fatigue is present in 10 to 25% of all patients visiting Australian Medical Practitioners. In the UK, 67% of men and 57% of women are either overweight or obese, and more than a quarter of UK children are also overweight or obese - 26% of boys and 29% of girls. About 2.1 billion people, or nearly one-third of the world’s population is obese or overweight, raising the risk of diabetes, heart disease and cancers.

“The most serious epidemic ever is insidiously engulfing the world”

Walter Willett, chair, Department of Nutrition, Harvard University
ENERGY BALANCE & OBESITY

The current approach in the management of obesity is to keep calorie intake below calorie expenditure. Achieving the desired weight loss requires accurate measurement of energy expenditure\(^1\). Daily energy expenditure is usually divided into the following three components:

(i) Resting Metabolic Rate (RMR), also known as Resting Energy Expenditure (REE), or Resting Energy Production (REP),
(ii) thermic effect of food, and
(iii) energy expended in exercise and physical activity\(^2\).

Of these, RMR accounts for 60 to 80% of total daily expenditure in sedentary individuals. RMR is an important factor of energy metabolism in humans and shows little day-to-day variation\(^3\). To keep calorie intake below calorie expenditure with a view to losing weight, RMR needs to be accurately measured\(^4,5\).

However, most weight management programs follow historical guidelines for treating overweight/obese individuals, which involve a low calorie-low fat diet, increased physical activity and behaviour modification.

The low calorie-low fat diet philosophy is designed to restrict dietary intake below the RMR level to create an energy deficit, which should allow for weight loss. Unfortunately this does not always happen as RMR levels are highly individual and other confounders occur.

Weight management professionals therefore have to use a predictive equation to estimate daily energy needs. Unfortunately, these equations (e.g. Harris-Benedict, developed in 1919, and Mifflin-St Jeor, developed in 1990) use basic demographic information (e.g. age, gender, weight and height) to determine RMR.

A limitation of these predictive equations is that they only estimate RMR and do not factor in the actual caloric requirements of various subjects who can be of the same sex, age, weight and height but have different body compositions (e.g. more muscle increases metabolism) and/or hormone function.\(^16\)

**WHY Measure Metabolism?**

In order to lose weight, it is critical to burn fat. The types and ratios of the food/fuel types (i.e. carbohydrates, fat, protein) consumed determine how the body metabolises these food/fuel types. If the body is not utilising energy from the burning of fat at rest, then the individual will not be able to effectively lose weight.

Respiratory Quotient (RQ) score indicates which fuels (Fat or Glucose) are being utilised and is a key component for weight loss and pre-diabetes management.
METABOLIC MEASUREMENT
The ability to accurately and quickly measure metabolism and determine how the body metabolises various food/fuel types, eliminates guesswork and provides a validatory control system for effective nutritional practice. Frequent measurement would allow practitioners to adjust caloric intake and caloric substrate ratios to ensure long term weight and energy management goals were met.

The Gold Standard for measuring Energy Expenditure is a technology called Indirect Calorimetry. This technology has been available for a number of years particularly in research and sports science departments. The technology is complex and requires specialist training.

However there is a clear need for a simple effective clinic based technology that can provide accurate detailed metabolic measurement without the need for specialist physiological knowhow.

ECAL ENERGY TESTING SYSTEM
ECAL from Metabolic Health Solutions is a compact Indirect Calorimeter, designed specifically for measuring metabolism at rest. ECAL has been validated against the reference Douglas Bag technique for metabolic studies at the School of Public Health, Curtin University of Technology, and is hailed as a welcome addition to the field of energy metabolism that has the potential to service both the research laboratory and health industry.

ECAL enables the measurement of RMR and other metabolic parameters using an easy 5-8 minute breath test and has been designed specifically for use by primary care health practitioners. It is compact, portable and very easy to use.

This energy measurement tool accurately measures energy expenditure, assesses for fuel usage and mitochondrial efficiency and provides health practitioners with the actual physiological information needed to achieve Energy Balance, the mainstay of modern successful weight loss and energy management programs. Given the significant health costs associated with obesity and the failure of current obesity strategies, the ability to accurately measure a person’s actual energy levels and efficiency is critical.

“ECAL takes the guess work out of obesity management”
ECAL assesses:

- Energy Expenditure
- Substrate Utilisation
- Energy Efficiency
- Effectiveness & progress of dietary or exercise intervention

The test is simplicity itself...
Just breathe normally into a single use, disposable mouthpiece for 5 minutes while sitting reclined on a comfortable chair.

Actual calorie expenditure at rest
Resting Metabolic Rate or Resting Energy Expenditure. This shows normal daily resting energy requirements and can indicate normal, high, or low metabolic rate.

Substrate Utilisation
The type of fuels (carbohydrates, fats or proteins) used to generate energy. The ratio of calories burned between the various types of fuels to generate energy sheds light on the effect of the various dietary interventions on a person’s metabolism. For instance, it is a measure of Fat Burning (critical for weight loss applications).

Metabolic Disease Assessment
Whether there is potential for an energy related metabolic disease, e.g. inability to metabolise carbohydrate or fat.

Mitochondrial efficiency
Pre test and post test questionnaires together with the test results, review mitochondrial performance and monitor any intervention strategies.
### PRACTITIONER REPORT

** CLIENT NAME: A. Client **

<table>
<thead>
<tr>
<th>Metabolic Parameter</th>
<th>Test Score</th>
<th>Normal Range</th>
<th>Optimal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resting Energy Production (REP) (kcal)</td>
<td>1698</td>
<td>1322 - 1616</td>
<td>N/A</td>
</tr>
<tr>
<td>Resting Energy Production (REP) (kJ)</td>
<td>7109</td>
<td>5535 - 6766</td>
<td>N/A</td>
</tr>
<tr>
<td>RQ Score</td>
<td>0.94</td>
<td>0.75 - 0.85</td>
<td>0.75</td>
</tr>
<tr>
<td>Fat Burning (%)</td>
<td>18.2</td>
<td>48 - 83</td>
<td>80</td>
</tr>
<tr>
<td>Glucose Availability (%)</td>
<td>81.8</td>
<td>17 - 52</td>
<td>20</td>
</tr>
<tr>
<td>Mitochondrial Efficiency ($FEO_2$) (%)</td>
<td>17.27</td>
<td>16 - 17</td>
<td>&lt; 15</td>
</tr>
<tr>
<td>Carbon Dioxide Production ($FECO_2$) (%)</td>
<td>3.55</td>
<td>3.5 - 4.5</td>
<td>3.5</td>
</tr>
<tr>
<td>Breathing Rate (breaths/min)</td>
<td>16.03</td>
<td>5 - 15</td>
<td>5 - 8</td>
</tr>
<tr>
<td>Breathing Volume (litres/breath)</td>
<td>0.48</td>
<td>0.4 - 1.0</td>
<td>0.50</td>
</tr>
</tbody>
</table>

** ECAL is a small metabolic monitor that has been built specifically to perform resting energy assessments using Indirect Calorimetry technology, the Gold Standard for measuring metabolic rate. It is designed and built in Australia, to ISO13485 & CE standards of manufacturing. CE approval was received in August 2014 and Australian TGA approval was received in December 2014. The Practitioner Report also contains, detailed explanations of each metabolic parameter and recommendations for management with relevant literature citations.**

**SAMPLE GRAPHICS FROM THE CLIENT REPORT**

The Practitioner Report also contains, detailed explanations of each metabolic parameter and recommendations for management with relevant literature citations.
“When we talk about WEIGHT LOSS, we really mean Fat loss, so it is important that your RQ score shows that you are burning FAT.”

“ECAL includes proprietary interpretative software, designed specifically to support better patient care.”
ECAL has the following advantages compared to other calorimeters:

1. **Affordable and Portable**
   “ECAL is the most affordable Indirect Calorimetry system on the market incorporating medical grade O₂ and CO₂ sensors.”

2. **Multifunctional**
   Can be used in a variety of settings, including General Medicine, Metabolic Assessment, Nutritional Prescription, Sports Medicine, Intensive Care, Exercise Rehabilitation and Respiratory Medicine.

3. **Ease of use**
   Requires minimal training to operate effectively due to its auto-calibration feature. Intelligent software designed by practitioners for practitioners, to help overcome the complexity of metabolic testing and interpretation. The software analyses raw metabolic data (inspired O₂, expired CO₂, flow rate) and provides written and visual interpretation of the client data in an intelligent, easy to understand format in the form of two reports, one for the client and the other for the health practitioner.

ECAL software can show before, during and after comparisons of four key energy parameters in a way that clients can understand:

1. **REP**
   This is the minimum amount of energy in calories that an individual requires each day to perform normal functions when mostly at rest.

2. **FeO₂**
   This is a measure of oxygen used to produce energy during normal breathing.

3. **FeCO₂**
   This is a measure of the amount of CO₂ produced from metabolism and expired during breathing.

4. **RQ**
   This is a ratio of how much of an individual’s energy is generated from burning fat. Long term weight loss should focus on stored fat reduction. Therefore the RQ score is an important indicator that the individual is burning FAT at rest.
   - The best score for BURNING Fat will be between 0.75 - 0.85
   - An RQ score of greater than 0.95 suggests FAT STORAGE is occurring

“ECAL is simple to use, compact, and very portable, perfect for use in a clinic setting. My practice has benefited immensely from the addition of ECAL to my services. I am now able to provide clients with individually tailored nutrition advice. I would strongly recommend the use of this technology for any dietitian working in Private Practice”

Nicola Lowth, PhD, APD, Perth, Australia
ECAL SPECIFICATIONS

Dimensions:
Width = 158 mm
Depth = 268 mm
Height = 67 mm
Weight = 1kg

Operations:
Power requirement = 12V 1.25A
Auto-calibration time = 10 seconds.
Environmental temperature = 10 to 35 °C.
Environmental humidity = 0 – 70% RH
Environmental pressure = 95 – 106 kPa
Breath-by-breath sampling and storage
USB A to B cable

ECAL is fully RoHS compliant

Oxygen Sensor:
Galvanic Fuel Cell
Range = 0 – 100 Vol. % O₂
Accuracy = ± 3% of reading

Carbon Dioxide Sensor:
Non-Dispersive Infrared Absorption
Range = 0 – 20 Vol. % CO₂
Accuracy = +/-70 ppm +/- 5% of reading

Volume Measurements:
Flow sensor
Temperature compensated transducer
Disposable mouth-piece with antibacterial filter

“Overall ECAL is a welcome addition to the field of energy metabolism and has the potential to service the needs of both the research laboratory and the health industry”
Prof M Soares, Curtin University
AS A DIETITIAN, I AM CONSIDERING TESTING RESTING METABOLISM FOR MY CLIENTS. WHY SHOULD I CONSIDER ECAL?

ECAL is the most affordable Indirect Calorimetry system incorporating O₂ and CO₂ sensors, on the market today. ECAL is easy to use as the intelligent software ECHealth was designed specifically for health and exercise practitioners to overcome the complexity of metabolic testing and interpretation. The software incorporates key physiological and metabolic algorithms that enable the health professional to make accurate and informed decisions about the nutritional health of their clients. Importantly the software is designed to highlight ‘false positives’, a common problem with current devices. Furthermore it provides easy to understand outputs for both the practitioner and their clients.

WHY IS RQ OF VALUE IN NUTRITIONAL MANAGEMENT?

The RQ (Respiratory Quotient) score is a measure of substrate utilisation. It indicates the ratio of fat and glucose used to produce energy. An RQ score above 0.95 indicates that glucose is the primary fuel source. When this occurs, insulin levels will increase, and fat oxidation will cease. A secondary function of insulin is the role in the conversion of glucose to fat through lipogenesis. Therefore identifying clients with high RQ levels indicates the high possibility of metabolic dysfunction and/or hyperinsulinemia, which may require dietary or hormonal correction.

AS A NEW COMPANY, WHAT KIND OF BACK UP SUPPORT DO I GET?

ECAL is a very stable instrument. However, we currently have business hours telephone support for our clients, a 48 hour replacement service for warranty issues and we are developing an online education and training facility.

AS A HEALTH PRACTITIONER, HOW WILL ECAL ADD VALUE TO MY PRACTICE?

Indirect Calorimetry has long been recognised as critical for effective metabolic management. However, to date it has been too expensive or too complicated for clinic use.

ECAL changes this and provides simple clear information about your clients’ metabolic and nutritional health. It can:

• Measure the amount of calories burnt per day
• Indicate whether your client is burning calories from fat or from glucose (carbohydrate)
• Measure how efficiently your clients make energy

Knowing your clients’ energy demands and how they utilise fuel allows you to prescribe effective nutritional and/or exercise prescription.

For more information please visit www.energytesting.com.au
REFERENCES


(9) Australian Government Department of Health & Ageing.


(12) Soares MJ (2012). ECAL: a new device to measure energy requirements of subjects in a clinic setting. School of Public Health, Curtin University, Australia.


