

# ECAL

Metabolic  
Management  
For The Clinic



Metabolic  
HEALTH SOLUTIONS

“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](http://www.metabolichealthsolutions.com.au)

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# 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<sup>7</sup>. 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<sup>9</sup>. Prolonged Fatigue is present in 10 to 25% of all patients visiting Australian Medical Practitioners<sup>10</sup>. 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<sup>11</sup>. 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<sup>11</sup>.

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

**Walter Willett, chair, Department of Nutrition, Harvard University**

## ENERGY BALANCE & OBESITY

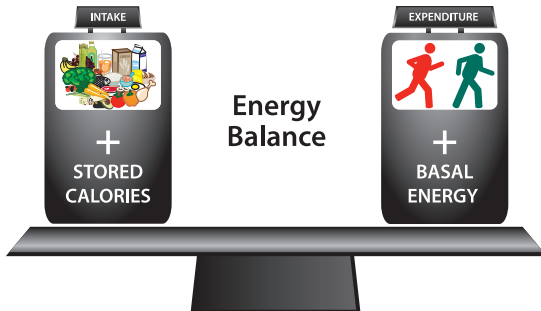
The current approach in the management of obesity is to keep calorie intake below calorie expenditure. Achieving the desired weight loss requires accurate measurement of energy expenditure<sup>1</sup>. Daily energy expenditure is usually divided into the following three components:

- (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<sup>2</sup>.

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<sup>3</sup>. To keep calorie intake below calorie expenditure with a view to losing weight, RMR needs to be accurately measured<sup>4,5</sup>.

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.<sup>16</sup>

## WHY Measure Metabolism?

Investigated differences between measured and predicted REE  
*Foster et al., Metabolism 37(5) 467-472, 1988.*

Subjects of Same Height & Weight	A	B	C	D	E
Predicted	1724	1740	1743	1744	1743
ACTUAL	1263	1523	1778	1979	2252

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<sup>11</sup>.

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

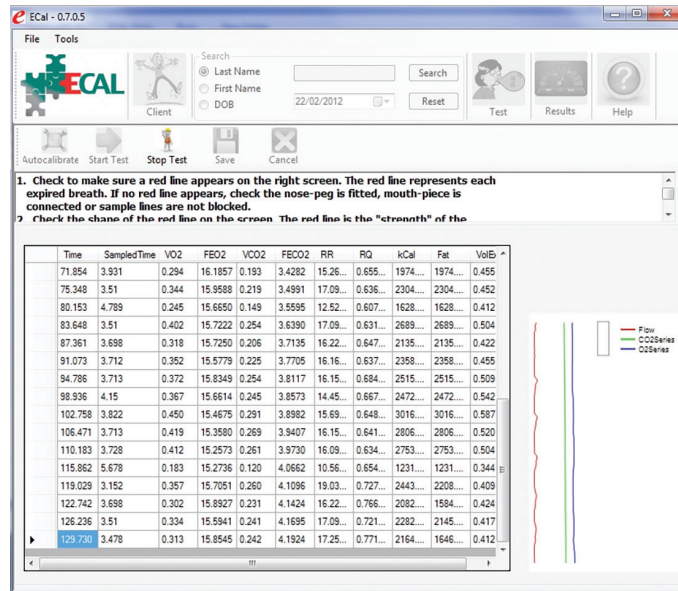
Whether there is potential for an energy related metabolic disease, e.g. inability to metabolise carbohydrate or fat.

## Mitochondrial efficiency

Pre test and post test questionnaires together with the test results, review mitochondrial performance and monitor any intervention strategies.



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.

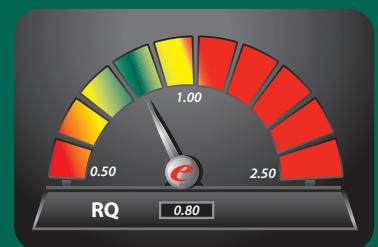
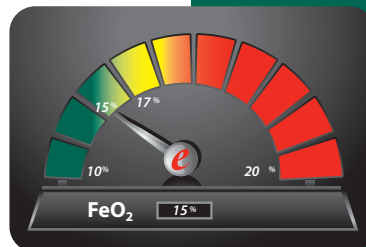


## PRACTITIONER REPORT

Date of Test: 22/09/2014 8:58:11 AM

CLIENT NAME: A. Client	Test Score	Normal Range	Optimal
Resting Energy Production (REP) (kcal)	1698	1322 - 1616	N/A
Resting Energy Production (REP) (kJ)	7109	5535 - 6766	N/A
RQ Score	0.94	0.75 - 0.85	0.75
Fat Burning (%)	18.2	48 - 83	80
Glucose Availability (%)	81.8	17 - 52	20
Mitochondrial Efficiency (FEO <sub>2</sub> ) (%)	17.27	16 - 17	< 15
Carbon Dioxide Production (FECO <sub>2</sub> ) (%)	3.55	3.5 - 4.5	3.5
Breathing Rate (breaths/min)	16.03	5 - 15	5 - 8
Breathing Volume (litres/breath)	0.48	0.4 - 1.0	0.50

### 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

High REP High RQ

Practitioner

- 1. High expired volume?  Yes  No
- 2. Good mitochondrial efficiency?  Yes  No
- 3. Fast breathing rate?  Yes  No

Poor mitochondrial efficiency

- Yes  No
- 1. Was the RQ score higher than normal?  Yes  No
- 2. Did the client score highly in the EFA questionnaire?  Yes  No
- 3. Are sex hormone levels likely to be reduced?  Yes  No
- 4. Does the client have low iron levels?  Yes  No
- 5. Has the patient been exposed to heavy metals or pesticides?  Yes  No
- 6. Does the client work close to high levels of electromagnetic radiation?  Yes  No
- 7. Is the client taking any medication?  Yes  No
- 8. Does the Krebs Cycle require investigation?  Yes  No

Client

- 1. Have you smoked a cigarette in the past four hours?  Yes  No
- 2. Have you had coffee, tea or soft drink in past four hours?  Yes  No
- 3. Have you eaten in the past four hours?  Yes  No
- 4. Have you performed any activity in the past twelve hours that would increase your body temperature?  Yes  No
- 5. Are you feeling hotter than normal?  Yes  No
- 6. Are you taking medication or supplements?  Yes  No
- 7. Do you have a known thyroid problem?  Yes  No
- 8. Have you recently been sick?  Yes  No
- 9. Are you currently stressed or anxious?  Yes  No

“ECAL includes proprietary interpretative software, designed specifically to support better patient care.”

“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 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 O<sub>2</sub> and CO<sub>2</sub> 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 O<sub>2</sub>, expired CO<sub>2</sub>, 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) FeO<sub>2</sub>

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

### (3) FeCO<sub>2</sub>

This is a measure of the amount of CO<sub>2</sub> 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




“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**

## 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. % O<sub>2</sub>  
Accuracy ± -3% of reading

### Carbon Dioxide Sensor:

Non-Dispersive Infrared Absorption  
Range 0 – 20 Vol. % CO<sub>2</sub>  
Accuracy +/-70 ppm +/- 5% of reading

### Volume Measurements:

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

# FREQUENTLY ASKED QUESTIONS

## 1. 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 O<sub>2</sub> and CO<sub>2</sub> sensors, on the market today. ECAL is easy to use as the intelligent software EHealth 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.

## 2. 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.

## 3. 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.

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

Indirect Calorimetry has long been recognised as critical for effective metabolic management<sup>14,15</sup>. 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](http://www.energytesting.com.au)

## METABOLIC HEALTH SOLUTIONS

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**Metabolic**  
— HEALTH SOLUTIONS —

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