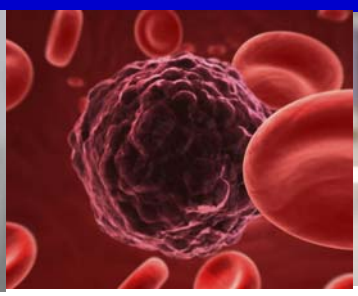
ILLNESS MARKER™

BIA Impedance Ratio

What is the Illness Marker?

Introduction

Bioelectrical Impedance Analysis (BIA), technology began in the mid 1980's with single frequency devices. These devices focused on the study of fat and fat free mass. Since then there have been many significant developments and technological advancements. Multifrequency devices are now common place, from two frequency to Bioelectrical Impedance Spectroscopy (BIS) devices offering up to 100 potential frequencies. We can now gain further insight of the body, particularly hydration status and fluid shifts. This advancement has many implications for the medical profession.

BIA is a technique to establish an individual's body composition (refer to the model below). The subject, whilst in a supine position, has two electrodes attached to the right foot and the right hand. The electrodes are then connected by lead wires to a handheld device and a small electrical signal is passed through the body. The Resistance and Reactance to the current is measured in Ohms and the body composition breakdown is then calculated using a series of algorithms.

This leaflet will explain how raw data, obtained from Multifrequency devices can be used to monitor Intracellular (ICW), Extracellular fluid (ECW) and Total Body Water (TBW), hence cellular health and nutritional status.

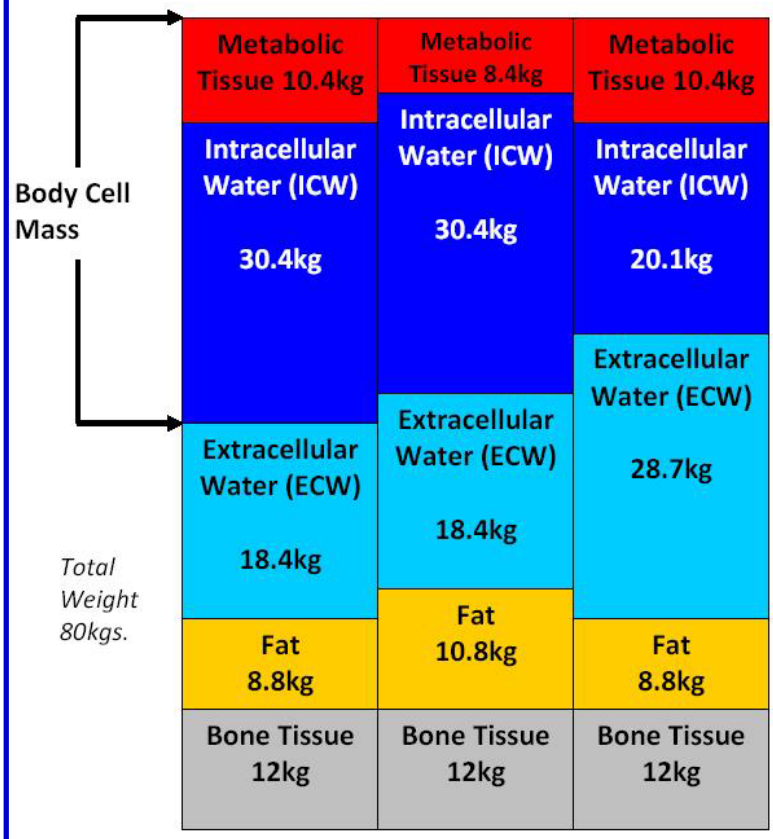
Who are we?

Bodystat Ltd, based on the Isle of Man (British Isles), has been established since 1990. We specialise solely in BIA Technology and are dedicated to the expansion of knowledge in this field to improve health and wellbeing. To this end, we have an extensive range of research papers (available on our website) as well as a Resource Centre dedicated solely to providing non-commercial materials for educators.

Our devices are manufactured in Europe, made to the highest specifications and use only the best electrical components. The high quality of our devices ensures accurate results that are both reproducible and reliable.

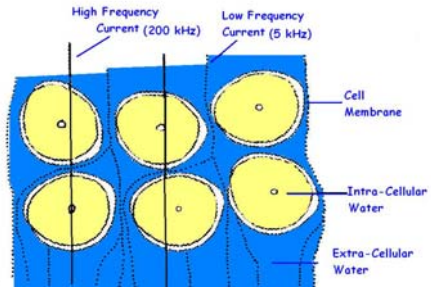
Bodystat®
CHALLENGING ATTITUDES TO HEALTHCARE
Est. 1990
CE0120

Model to Illustrate Shifts in Body Composition & Body Cell Mass



What is the Illness Marker™?

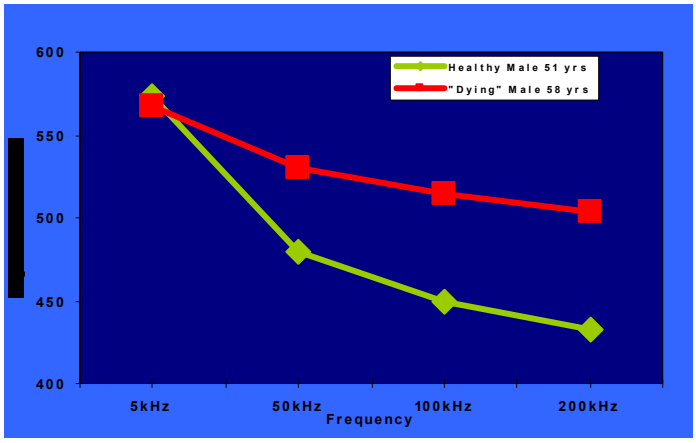
BioElectrical Properties

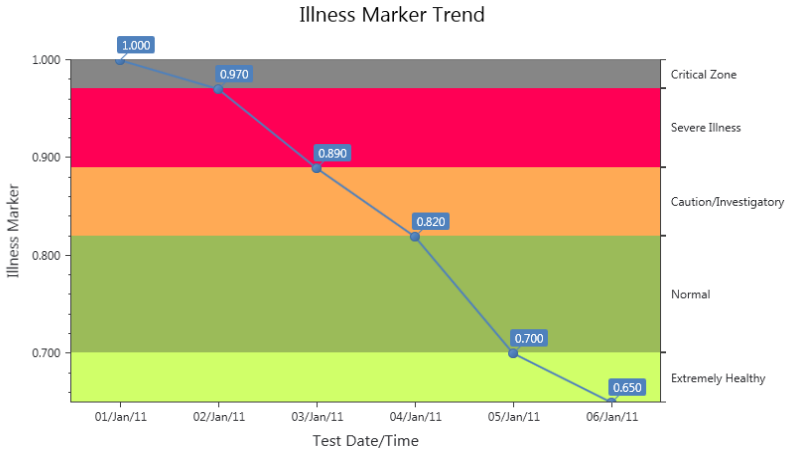


The Illness Marker™

The Illness Marker or Impedance Ratio is the ratio between the impedance measurement at 200 kHz and 5 kHz. At 200 kHz the current is strong enough to penetrate the cell membrane and therefore Total Body Water (TBW) can be measured. However, at 5 kHz the membrane cannot be penetrated and only Extracellular Water (ECW) can be measured. Intra Cellular Water (ICW) is derived by TBW-ECW. The greater the variance between the two impedance values at 5 kHz and 200 kHz the healthier the body cells. To allow easy monitoring of change, these figures are expressed as a ratio. A ratio closer to 1.00 indicates poor cellular health or extreme fluid overload. The table below illustrates the normal ranges as experienced by Bodystat.

The graph below illustrates actual data of a "dying" male. Note that the curve is much flatter compared to that of the healthy male. When considering this data, the steeper the curve, the healthier the body cell.





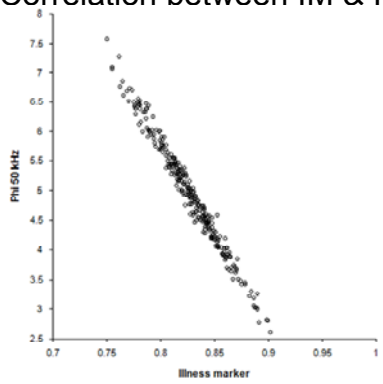
Expansion of ECW and loss of ICW are typical features of systemic illness, arising from protein leakages into the extra-cellular space and loss of intra-cellular protein.

Loss of intra-cellular potassium and extra-cellular accumulation of sodium result in an increased whole-body exchangeable Na+-K+ ratio, which is a strong predictor of mortality in surgical patients. The resistance of the cell membrane at 5 kHz, is therefore significantly reduced in the case of critical illness and the difference between the Impedance values at 5 kHz and 200 kHz is markedly closer to each other resulting in a higher ratio, indicating cellular deterioration.

Phase Angle

Kyle et al[1] and Castillo-Martinez et al[2] are just two of many researchers to publish papers that state the Phase Angle (PA) may be used as an indicator of cellular health. Castillo-Martinez concluded that not only was PA ***"an independent predictor of all-cause mortality in chronic heart failure"***, but also that a ***"smaller PA was associated with malnutrition".*** More recently, Kyle, in a study to establish cut-off values for the PA in a comparative study with Nutritional Risk Screening **(NRS)** and Subjective Global Assessment **(SGA),** also looked at the relationship of PA and **Serum Albumin**. This study established a cut-off for the PA of 5.0° (men) and 4.6° (women). Importantly the study concluded that against these parameters, ***"PA appears to be a useful screening tool to assess nutritional risk without having to measure weight or height"***; furthermore concluding that ***"PA is of interest because it is a non-invasive, objective, direct, quick (less than 2 min) method to determine nutritional and morbidity risks in patients"*** while NRS and SGA are subjective and time consuming. These are key concepts in the use of either the PA or the Illness Marker. **It can be used on any population, age or gender and is independent of weight or height.**

Correlation between IM & Phase Angle (PA)



"Correlation between IM & PA is very tight"

**Pending publication, based on sample of 277 subjects*

The PA is a calculation at 50kHz. The biological meaning of PA is not completely understood whereas IM is simply using the raw data Impedance Values, a direct measurement and recognised as a substitute for PA. Recent research suggests that not only is the correlation between the Illness Marker and the PA 'very tight' but that it is also easier to use in a clinical situation, as well as easier to understand and explain the origins of the data.

[1] Kyle UG, et al., Can phase angle determined by bioelectrical impedance analysis assess nutritional risk? A comparison between healthy and hospitalized subjects, Clinical Nutrition (2012), doi:10.1016/j.clnu.2012.04.002

[2] Castillo-Martinez, et al., Bioelectrical impedance phase angle as a prognostic marker in chronic heart failure, Nutrition (2012), doi:10.1016/j.nut.2011.11.033

How does this help me?

Management Efficiencies to Consider

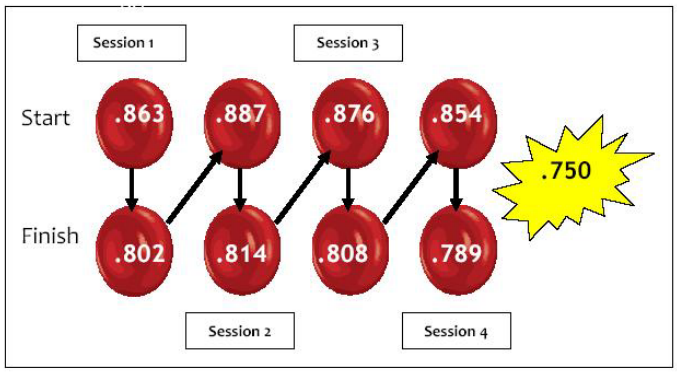
Unfortunately, a Clinical Practitioner must no longer only consider their patient's health and wellbeing, but also Management Efficiencies. With the ability to monitor fluid shifts and cellular health comes the additional advantage of being better equipped to predict patient outcome, allowing Clinicians to more effectively manage their resources.

"An essential part of a Clinicians Tool Kit"

- Consider if intervention is effective before clinical symptoms occur
- Ability to change intervention type if there is no improvement
- Length of stay in hospital could be reduced, freeing up bed space
- Reduce repeat visits by identifying those at risk.

Tracking Change

To realise the full potential of the Illness Marker it should be tracked over a period of time. The ideal situation would be for the Illness Marker to be taken prior to treatment and this figure to be used as a benchmark, then measured again during intervention, post-treatment and on follow-up appointments. By using this technique as a Clinician you will be able to monitor the cellular health of the individual and to see the effectiveness of your intervention, be this drug therapy, surgery or nutrition. This tracking should be done at an interval to suit your requirements, this may be over a period of months, weeks, days or hours.



Body Cell Mass (BCM)

The BCM (Metabolic tissue and ICW) is a very important element of the study of body composition, as it is indicative of Nutritional Status (refer to the model on the front page). In omitting to monitor ICW and ECW shifts in the body composition when monitoring only the weight or BMI (Body Mass Index), declines in health may not be identified.

In other words, decreases in the BCM can be obscured by an expansion of ECW. Furthermore, BMI does not reflect nutritional status in ill patients, as the decrease in BCM is obscured by an expansion of ECW.

BMI does not reflect Nutritional Status!

Fluid Shifts

The development of oedema after major surgery is associated with increased morbidity. Oedema formation is related to fluid balance and clinical outcome. An important study revealed that the pre-operative ratio of whole body Impedance at 200 kHz to that at 5 kHz was higher in those who subsequently developed oedema thus identifying patients at risk before surgery.

In the **Intensive Care Unit (ICU)** impedance measurements can easily be made as frequently as deemed necessary without disturbance to a patient to monitor and track the changes in the ratio. An increasing ratio may indicate a potential deterioration in the clinical condition of a patient.

Segmental Applications

The Illness Marker can also be used for segmental analysis. Once again, the Clinician would track the deviation from the benchmark measure over a period of time.

The most important consideration is the placement of electrodes. Whether you are measuring the arm, leg, or trunk you must choose an anatomical marker which is easily found for accurate reproducible measurements. Popular applications for this method are Lymphedema, Rehabilitation, Stroke and Surgery.

Whole Body Applications

Whole body assessment is a popular use of the Illness Marker. It has been found along with Phase Angle, to be a useful screening tool to assess both the nutritional risk of a patient and used as an independent predictor of outcome and mortality. Most importantly this can be used with bedbound patients as no height or weight is required.

Illness Marker and Phase Angle are currently used throughout many different critical care environments, including, Oncology, HIV, Surgery, Paediatrics, Dialysis and Critical Care Units.

Illness Marker:

The latest Multi-Frequency BIA & BIS Electronic Technology

ANY: Disease State ~ ANY: Age Group ~ ANY: Population Group ~ ANY: Gender

Quick to perform ~ Easy to use ~ Little or no training required

Non-invasive ~ Portable ~ Practical ~ No height or weight required

Inexpensive technology ~ Cost effective

Substantiating Research

Research papers

"Phase Angle has been used as a prognostic indicator in various clinical populations. In this mixed inpatient group, the Impedance Ratio (Illness Marker) appears to better predict nutritional status and Length of Stay compared to Phase Angle."

Impedance ratio Z200/Z5 compared to phase angle at 50 kHz better predicts nutritional status and length of stay in hospitalized patients. (Earthman C., Kruizenga H.M., Weijs P.J.M.) *Published at the 9th International Symposium on In Vivo Body Composition Studies, Hangzhou, China 2011*

"A preoperative low bioelectrical impedance phase angle is associated with undernutrition, and increases the risk of adverse clinical outcome after cardiac surgery. The phase angle might help to identify undernourished cardiac surgical patients."

The bioelectrical impedance phase angle as an indicator of undernutrition and adverse clinical outcome in cardiac surgical patients (Visser M. Et al) PII: S0261-5614(12)00102-1 doi:10.1016/j.clnu.2012.05.002 , 2012 Published by Elsevier Inc.

"Recognition and correction of chronic fluid overload based on age-stratified Calf-BR is helpful in hypertension control in Chinese HD patients."

Calf Bioimpedance Ratio Improves Dry Weight Assessment and Blood Pressure Control in Hemodialysis Patients. (Yi-Lun Zhou et al) *Am J Nephrol 2010;32:109–116*

"Patient population is obese. Bioimpedance measurements can distinguish between high fat content of the body and/or fluid overload. Significant differences are present according to the functional status in body water spaces and Illness Marker. There is a trend in the measured impedance data towards lower values in more severe cases. The significant difference detected in the difference between the measured impedance values reflects the clinical situation. Illness Marker and BIA can be used to track changes occuring during the course of the disease. The correlations between the body water spaces and IM and functional class show the potential clinical role of IM."

Preliminary results for use of Illness Marker in heart failure patients (Bozó R.K., Lelovics Z.) *Published at the ESPEN congress 2009*

"The performance of IM from MBIA as a prognostic tool was comparable to APACHE in this sample of ICU patients. Future studies may determine the best IM cut-off value to be used in this population."

Illness Marker as a prognostic tool in intensive care unit: a prospective study (Gonzalez M.C. et al) *Presented at the American Society for Parenteral and Enteral Nutrition, Nutrition Week Congress, New Orleans, USA, February 2009 & Journal of Parental and Enteral Nutrition; Volume 33, Number 2. March-April 2009. SP-10. Page 219.*

"The figures found by BIA of poor conductive tissue increase, that the device interpreted as an increase of fatty mass (poor conductor), isn't the organism's behaviour against malnutrition. The patients were malnourished as shows their low body mass index and it worsened as time went on. In the first patient there was an increase of lung fibrosis and probably of other tissues as well, which lead to death in respiratory failure. In the second patient the increase of fibrous tissue was manifested ostensibly through a refractory restrictive heart failure that also lead to death. The increase of Resistance, and the decrease of Reactance and Phase Angle can be correlated to the severity of the disease and they seem to be sensitive markers of its progression (activity markers)."

Bioelectrical Impedance Analysis of Patients with Scleroderma as an Indicator of Severity and Activity of the Disease. (Arias Sylvia M. D. et al) *Paper presented at the 29 World Congress of Medicine at Buenos Aires, Argentina, September 2008*

"As conclusion, the RI (Impedance Ratio) is an alternative for evaluation of the cell membrane, that can be of utilised as an indicator in clinical situations. Longitudinal studies in diverse clinical situations and intervention studies should be carried out to verify its performance."

Razón de Impedancias: novo parámetro para evaluación funcional a partir de Bioimpedancia eléctrica multifrecuencial. Barbosa e Silva *Presented at FELANPE, November 2005*

"These findings show that, even when the healthiest group of CKD patients is considered, CKD patients have elevated Illness Markers, indicative of poor cellular health. Interestingly, this finding was independent of body composition, absolute impedance values, total body water and extra-cellular water. This simple measure may offer a novel approach to evaluating and tracking cellular health in the haemodialysis population."

Multi-Frequency Bioelectrical Impedance Analysis and Cellular Health in Mobile CKD Patients *Razón de Impedancias: novo parámetro para evaluación funcional a partir de Bioimpedancia eléctrica multifrecuencial.* (Mason L. et al) *Journal of the American Society of Nephrology (JASN) 19:2008. Ref.PUB638*

ESPEN Blue Book: As well as mention of Phase Angle applications, the Illness Marker is discussed in the chapter on Basic Concepts in Nutrition. Described as a *"newer way to evaluate cell membrane function"* and *"as a reliable guide to prognosis" (of patients in Intensive Care Units)*. The Illness Marker is unique to Bodystat and since its inception has been used in many research areas. Basics in Clinical Nutrition, Fourth Edition, ESPEN (Galén) 2011

Bodystat Ltd
Ballakaap, Ballafletcher Road, Cronkbourne, Douglas
ISLE OF MAN, British Isle, IM4 4QJ
info@bodystat.com
+44-(0)1624-629 571 **+44-(0)1624-611 544**

Version 01/12

More information? Visit: www.bodystat/research.com