

Bioimpedance Illness Marker Compared to Phase Angle as a Predictor of Malnutrition in Hospitalised Patients

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Introduction

Bioelectrical impedance analysis (BIA) is a non-invasive and easily applied technique which is now widely used in clinical settings. The measured impedance to an alternating current comprises reactance, due to the presence of cellular interfaces which lead to capacitive effects, and resistance due to the presence of extracellular and intracellular electrolyte.

Changes in reactance may indicate loss of cellular tissue or alteration in cell integrity while resistance changes will reflect changes in body fluid compartments.

Phase angle (PA) is calculated as the arctangent of the ratio of reactance to resistance usually at a single frequency of 50 kHz. Low PA is associated with poor survival in chronic conditions such as colorectal cancer [1], HIV [2], liver cirrhosis [3], and heart failure [4] and may have value in identifying poor nutritional status [4,5].

Multifrequency BIA permits determination of the ratio of impedances at 200 and 5 kHz, proposed as an illness marker (IM™, Bodystat Ltd), since it increases with fluid overload and reduction of the intracellular fluid space (and cell mass). IM, therefore, may also be a useful indicator of nutritional status.

Aim

To compare phase angle (PA) and illness marker (IM) for their utility in predicting malnutrition in hospitalised patients.

Methods

Bioimpedance measurements were carried out in 109 hospital patients with gastrointestinal disorders who were referred for parenteral nutritional support and underwent determination of total body protein (TBP) by neutron activation analysis.

PA was derived from resistance and reactance measurements at 50 kHz (BIA-101, RJL Instruments) and IM from bioimpedance spectroscopy (4000B, Xitron Technologies). The same measurements carried out in healthy volunteers were used to establish cut-offs for low (abnormal) PA (<5.0° M, <4.1° F; n=364) and high (abnormal) IM (>0.78 M, >0.82 F; n=151).

Patients were assessed as being significantly malnourished if measured TBP was <77% of that predicted from regression equations based on sex, age and height established in 386 healthy volunteers (Fig. 1).

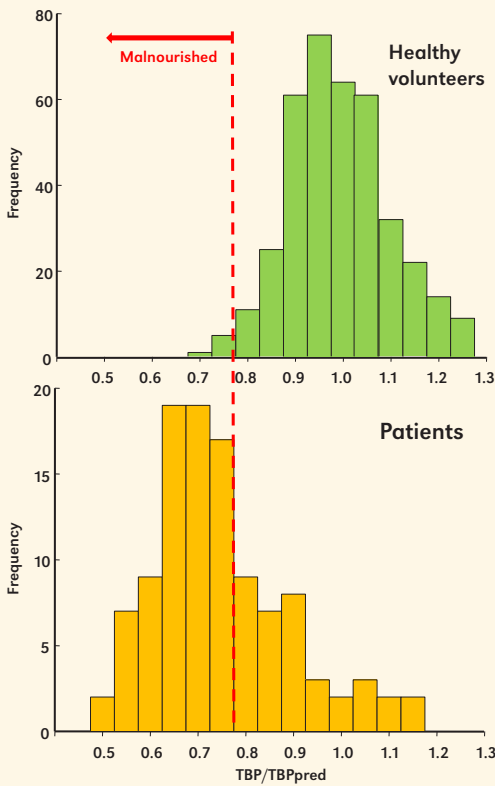


Fig. 1. Frequency distributions for the ratio of measured to predicted total body protein in 386 healthy volunteers and 109 patients.

Results

Table 1. Patient characteristics.

	Male (n=52)	Female (n=57)
Age (y)	50.6 ± 19.4 (17 – 87)	57.6 ± 16.1 (22 – 87)
Weight (kg)	66.2 ± 13.6 (44.8 – 96.9)	56.6 ± 13.2 (33.7 – 93.1)
BMI (kg/m²)	22.3 ± 4.4 (16.5 – 33.4)	21.9 ± 5.1 (13.9 – 36.8)
Total body protein (kg)	8.53 ± 1.78 (5.46 – 12.99)	6.03 ± 1.49 (3.59 – 11.27)
Malnourished	34 (65%)	37 (65%)
Phase angle (°)	5.71 ± 1.33 (1.00 – 8.40)	5.37 ± 1.31 (3.10 – 10.50)
Low phase angle	13 (25%)	9 (16%)
Illness marker	0.811 ± 0.041 (0.747 – 0.946)	0.825 ± 0.044 (0.642 – 0.912)
High illness marker	41 (79%)	33 (58%)

Mean ± SD (range) or Number of patients (%)

PA and IM were highly correlated (r = -0.97, p<0.0001). Of the 71 malnourished patients, 16 were detected by PA and 56 by IM (Table 2).

Table 2. Classification of malnutrition by total body protein, phase angle and illness marker in 109 patients.

		Body protein status		
		Normal	Malnourished	Total
Phase angle	Normal	32	55	87
	Low	6	16	22
	Total	38	71	109
Illness marker	Normal	20	15	35
	High	18	56	74
	Total	38	71	109

Table 3. Sensitivity, specificity and predictive value of phase angle and illness marker in determining malnutrition in hospital patients.

	Phase angle	Illness marker
Sensitivity	23%	79%
Specificity	84%	53%
Positive predictive value	73%	76%
Negative predictive value	37%	57%

High IM was associated with a 4.15-fold (95% CI: 1.77-9.75, P=0.001) increased odds of being malnourished while for low PA the corresponding odds ratio was 1.55 (0.55-4.37, P=0.41). Each 0.1 increase in IM was associated with a 4.64-fold (1.65-15.13, P=0.006) and each unit decrease in PA a 1.55-fold (1.10-2.18, P=0.012) increased odds of malnutrition.

Conclusions

Both PA and IM are derived from raw bioimpedance data without the need for intermediate equations.

In this patient group, IM was a more sensitive indicator of malnutrition than PA and may have application in bedside assessment of nutritional status.

References

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