Factors associated with phase angle in critically ill children

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Aims: Phase angle (PA), evaluated by bioelectrical impedance analysis, can be used as an indicator of cell membrane integrity and as a prognostic indicator in clinical situations. The aim of this study was to evaluate the variables associated with PA in critically ill children.

Methods: Prospective cohort study conducted in a Pediatric Intensive Care Unit (PICU) with children aged between 1 month and 15 years. Demographic and clinical data were assessed at admission. Bioelectrical impedance analysis, laboratorial and anthropometric measures were performed within 72 hours of admission. Clinical outcomes of PICU and hospital length of stay (LOS), nosocomial infection and overall mortality were assessed. Man-Whitney, Fisher's Test, linear and logistic regression were applied. P-value <0.05 was considered significant.

Results: A total of 76 patients were included, 54% male, median age of 1.9 (Interquartile range (IQR) 0.33; 9.07) years and median Pediatric Index of Mortality (PIM-2) of 2.35% (IQR 0.95; 6.8) (Table 1). Lower PA was associated with higher C-reactive protein (CRP) (mg/L) (p=0.048) and with higher CRP/albumin ratio (mg/dL:g/dL) (p=0.038), even after adjustment for sex, age and PIM-2 (p=0.02 and p=0.014, respectively). It was observed a direct association between thigh circumference and PA (p=0.046); however the significance was lost after adjustment (Table 2). There was no difference in clinical outcomes (data not shown).

Conclusion: PA was associated with inflammatory and anthropometric markers in critically ill children. More studies are necessary to evaluate the usefulness of PA in this population.

Keywords: Pediatric Intensive Care Units. Phase angle. Bioelectrical impedance analysis.

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Table 1 – Baseline characteristics of critically ill children at admission in Pediatric Intensive Care Unit.

Variables	**Total (n=108)**	**BIA (n=76)**	**without BIA (n=32)**	**p-value**
Sex (male) n (%)	58 (53.7)	36 (47.37)	22 (68.75)	0.057[1]
Age (years)	1.97 (0.33; 9.07)	4.7 (0.79; 10.09)	0.29 (0.15; 0.75)	**<0.001[2]**
PIM-2 (%)	2.35 (0.95; 6.8)	1.9 (0.6; 4.65)	3.8 (1.65; 12.95)	
Diagnostic				**<0.001[1]**
Medical	68 (62.96)	40 (52.63)	28 (87.50)	
Surgical	40 (37.04)	36 (47.37)	4 (12.50)	
Nutritional status				
z-BMI	-0.06(-4.76; 10)	-0.04 (-4,76; 7.24)	-0.10 (-2.21; 10)	0.316

[1]Fischer [2]Mann-Whitney; PIM 2 – Pediatric Index of Mortality; z-BMI – z-score of body mass index; BIA – Bioelectrical impedance analysis

Table 2 – Linear regression of variables associated with phase angle at admission in critically ill children (n=76).

Variables	Phase angle* at admission (n=76)			
	Crude		Adjustment**	
	β (95%CI)	p-value	β (95%CI)	p-value
Patients characteristics				
Sex (male)	0.18 (-0.99;0.47)	0.199	-	-
Age (years)	0.02 (-0.00;0.05)	0.075	-	-
Clinical				
Prematurity (n=34)	0.17 (-0.49;0.82)	0.611	0.23 (-0.50;0.95)	0.530
PIM-2	0.00 (-0.01;0.02)	0.850	-	-
Hospitalized before PICU	0.06 (-0.24;0.37)	0.668	0.02 (-0.30;0.33)	0.913
MV (at admission)	-0.00 (-0.29;0.28)	0.984	0.00 (-0.30;-0.31)	0.984
Edema (n=75)	0.24 (-0.11;0.59)	0.175	0.32 (-0.04;0.68)	0.082
Diagnostic (medical)	0.17 (-0.11;0.46)	0.224	0.15 (-0.15;0.45)	0.318
Anthropometry at admission				
Weight/age (z-score) (n=59)	0.08 (-0.35;0.52)	0.693	0.01 (-0.10;0.12)	0.846
Height/age (z-score) (n=75)	0.05 (-0.03;0.14)	0.202	0.06 (-0.03;0.14)	0.182
Weight/height (z-score) (n=41)	-0.02 (-0.12;0.09)	0.733	-0.02 (-0.13;0.08)	0.642
BMI/age (z-score)	-0.00 (-0.09;0.07)	0.858	-0.03 (-0.11;0.05)	0.430
MUAC/age (z-score) (n=66)	0.03 (-0.06;1.11)	0.522	0.02 (-0.06;0.11)	0.616
TC (cm) (n=64)	0.02 (0.00;0.03)	**0.046**	0.02 (-0.01;0.05)	0.247
MUAMC (cm^2) (n=56)	0.00 (-0.04;0.04)	0.908	-0.04 (-0.13;0.05)	0.363
Undernutrition (BMI <-2 z-score)	-0.11 (-0.65;0.42)	0.667	-0.11 (-0.65;0.42)	0.672
Undernutrition (MUAC <- 2 z-score) (n=66)	-0.33 (-0.75;0.10)	0.130	-0.32 (-0.74;0.11)	0.144
Laboratorial exams at admission				
CRP (mg/L) (n=69)	-0.00 (-0.00;-0.00)	**0.048**	-0.00 (-0.00;-0.00)	**0.025**
CRP (>6 mg/L) (n=69)	-0.15 (-0.45;0.14)	0.313	-0.16 (-0.45;0.13)	0.276
CRP/albumin ratio (mg/dL:g/dL)	-0.00 (-0.01;-0.00)	**0.038**	-0.00 (-0.01;-0.00)	**0.014**
1º tertile	1.00	-	1.00	-
2º tertile	-0.01 (-0.38;0.36)	0.948	0.16 (-0.21;0.53)	0.384
3º tertile	-0.36 (-0.74;0.03)	0.067	-0.44 (-0.81;-0.07)	**0.019**
Creatinine (mg/dL) (n=75)	0.04 (-0.17;0.27)	0.679	0.02 (-0.20;0.24)	0.829
Albumin (g/dL) (n=67)	-0.08 (-0.42;0.27)	0.660	-0.02 (-0.36;0.33)	0.924

Albumin (<3g/dL) (n=67)	-0.01 (-0.42;0.39)	0.938	-0.03 (-0.42;0.37)	0.888
Pre-albumin (g/dL) (n=10)	0.04 (-0.04;0.12)	0.242	0.03 (-0.07;0.14)	0.451
Urea (mg/dL) (n=72)	0.00 (-0.00;0.00)	0.539	0.00 (-0.00;0.00)	0.510
Sodium (mmol/dL)	-0.02 (-0.05;0.01)	0.228	-0.02 (-0.05;0.01)	0.208
Lymphocytes (n=13)	0.00 (-0.00;0.00)	0.693	0.00 (-0.00;0.00)	0.649

*logarithm **adjusted for sex, age and PIM 2; CI – 95% confidence interval; MV – mechanical ventilation; CRP – C-reactive protein; PICU – Pediatric Intensive Care Unit; BMI – body mass index; MUAMC – mid-upper arm muscle circumference; PIM-2 – Pediatric Index of Mortality; TC – thigh circumference; MUAC – mid-upper arm circumference.