Factors associated with Mid-Upper Arm Circumference impairment in Mechanical Ventilated Critically Ill Children

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Purpose: Critically ill children can experience an impairment of nutritional status during Pediatric Intensive Care Unit (PICU) stay. And, the nutritional status impairment is associated with duration on mechanical ventilation (MV), PICU and hospital length of stay and mortality. Thus, to prevent the impairment of nutritional status and its complications, during PICU stay, it is essential the early identification the factors associated with nutritional depletion. We aimed to evaluate the association between anthropometric, biochemical, nutritional therapy (NT) and clinical parameters with mid-upper arm circumference (MUAC) impairment in critically ill patients on MV.

Methods: Prospective cohort study conducted in a PICU of a tertiary hospital in south of Brazil, between July 2013 and February 2016, with critically ill children in MV, aged between 3 months and 15 years. Anthropometric parameters, evaluated by z-score of weight-for-age, body mass index-for-age (BMI/A), MUAC-for-age (MUAC/A) and triceps skinfold thickness-for-age, was performed at PICU admission and after 7 days. Biochemical evaluation was composed of serum albumin, C-reactive protein (CRP) and CRP/albumin ratio. NT was evaluated by prior NT, time to initiation, route of administration and energy and protein adequacy. Pediatric Index of Mortality 2 (PIM 2) illness severity score, diagnostic category (medical and surgical), Complex Chronic Conditions (CCC) and fluid overload were evaluated. Impairment of MUAC was defined as a reduction of at least 0.67 z-score of MUAC/A after 7 days. Chi-square test and Mann-Whitney was applied. Logistic regression crude and adjusted for age and PIM 2 (Adjustment 1) and for age and fluid overload (Adjustment 2) was used to evaluate the association between clinical and nutritional parameters with the impairment of MUAC. P-value < 0.05 was considered significant.

Results: There were included 53 patients, median age of 43.8 (Interquartile range 8.7 - 124.6) months. The prevalence of undernutrition at admission was 7.7% according BMI/A and, MUAC impairment was observed in 32% of the patients. There were no difference between patients with and without MUAC impairment (Table 1). Albumin concentration at PICU admission was associated with the impairment of MUAC in crude analysis (OR 0.2; p = 0.017), adjustment 1 (OR 0.2; p = 0.013) and adjustment 2 (OR 0.2; p = 0.021). Hypoalbuminemia (< 3.0 g/dL) at admission was associated with the impairment of MUAC in crude analysis (OR 5.3; p = 0.013), adjustment 1 (OR 6.8; p = 0.008) and adjustment 2 (OR 5.2; p = 0.020). Higher values of CRP/albumin ratio were associated with the impairment of MUAC in crude analysis (OR 11.7; p = 0.023), adjustment 1 (OR 40.5; p = 0.018) and adjustment 2 (OR 14.1; p = 0.024) (Table 2). There were no association between anthropometric, clinical or NT parameters with the impairment of MUAC (Table 2).

Conclusion: The evaluation of albumin and CRP/albumin ratio could be included in the nutritional status assessment at PICU admission for early identification of the risk of nutritional status impairment.

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Table 1 - Demographic, clinical and nutritional characterization of critically ill children on mechanical ventilation in a Pediatric Intensive Care Unit, between July 2013 and February 2016 (n = 53).

Variables	Without impairment of MUAC (n = 36)	With Impairment of MUAC (n = 17)	p-value
Sex (male) ¹	20 (55.56)	10 (58.82)	0.823^{3}
Age (months) 2	48.34 [8.10; 133.10]	40.75 [11.05; 77.84]	0.661^4
Diagnostic category ¹			
Medical	30 (83.33)	14 (82.35)	1.000^{3}
Surgical	6 (16.67)	3 (17.65)	
	5 (13.89)	2 (11.76)	1.000^{5}
PIM 2 $(\%)^2$	8.05 [1.80; 28.15]	8.00 [1.60; 18.10]	0.812^{4}
Nutritional status			
$(n = 52)^{*1}$			
Undernutrition (< -2)	2 (5.71)	2 (11.76)	0.482^{3}
Nutritional risk (< -1)	3 (8.57)	3 (17.65)	
Eutrophic	26 (74.29)	9 (52.94)	
Overweight	4 (11.43)	3 (17.65)	
Impairment of			
nutritional status			
Any parameter $(n = 53)^{-1}$	5 (13.89)	17 (100.00)	-
$W/A (n = 18)^{-1}$	1 (9.09)	0 (0.00)	-
BMI /A $(n = 19)^{1}$	3 (25.00)	2 (28.57)	1.000^{5}
MUAC/A $(n = 53)^{1}$	0 (0.00)	17 (100.00)	-
$TSF/A (n = 39)^{-1}$	2 (7.69)	2 (15.38)	0.589^{5}

MUAC: mid-upper arm circumference; CCC: Chronic Complex Condition; PIM 2: Pediatric Index of Mortality 2; BMI/A: body mass index-for-age; MUAC/A: mid-upper arm circumference-for-age; TSF/A: triceps skinfold thickness-for-age

* assessed at PICU admission, by BMI/A ¹ n (%); ² median [interquartile range]; ³ Chi-square Pearson; ⁴ Mann-Whitney; ⁵ Chi-square Fisher

	Impairment of mid-upper arm circumference (n = 17)							
Variables -	Crude		Adjustment 1 ⁺		Adjustment 2 ⁺⁺			
	OR (CI95%)	p- value	OR (CI95%)	p- value	OR (CI95%)	p- value		
Sex (female)	0.87 (0.27; 2.81)	0.823	-	-	-	-		
Age (< 36 months)	0.99 (0.31; 3.15)	0.991	-	-	-	-		
Diagnostic (Surgical)	1.07 (0.23; 4.92)	0.929	-	-	-	-		
CCC	0.83 (0.14; 4.77)	0.831	-	-	-	-		
PIM 2 (%)	0.99 (0.97; 1.02)	0.764	-	-	-	-		
Albumin (g/dL) $(n = 52)$	0.23 (0.07; 0.77)	0.017	0.20 (0.06; 0.72)	0.013	0.24 (0.07; 0.81)	0.021		
Hypoalbuminemia $(< 3.0 \text{ g/dL}) (n = 52)$	5.31 (1.42; 19.87)	0.013	6.82 (1.64; 28.32)	0.008	5.19 (1.29; 20.91)	0.020		
High CRP (> 6.0 mg/dL) (n = 49)	5.62 (0.65; 48.99)	0.118	6.22 (0.68; 57.30)	0.106	6.61 (0.72; 60.88)	0.096		
CRP/Albumin ratio (mg/dL:g/dL) (n = 49)								
1° tertile	1.00		1.00		1.00			
2° tertile	7.80 (0.08; 75.64)	0.076	23.95 (1.20; 477.99)	0.038	11.29 (1.04; 121.92)	0.046		
3° tertile	11.70 (1.26; 108.20)	0.030	40.46 (1.88; 869.90)	0.018	14.13 (1.42; 140.98)	0.024		
Nutritional status (BMI/A) (n = 52)*								
Eutrophic	1.00	0.203	-	-	-	-		
Nutritional risk/ undernutrition (< -1)	2.89 (0.68; 12.35)		-	-	-	-		
Overweight	2.17 (0.40; 11.60)		-	-	-	-		
Prior NT	0.99 (0.31; 3.15)	0.991	-	-	-	-		
Early NT (24 hours)	2.07 (0.56; 7.63)	0.275	-	-	-	-		
Route of NT (parenteral)	1.71 (0.34; 8.69)	0.515	-	-	-	-		
Energy cumulative deficit (kcal/day)**	1.00 (1.00; 1.00)	0.893	-	-	-	-		
Protein cumulative deficit (g/day)**	1.00 (1.00; 1.01)	0.176	1.00 (1.00; 1.01)	0.272	1.01 (1.00; 1.02)	0.204		
Fluid overload (> 20 mL/kg/day)	0.58 (0.17; 2.01)	0.393	-	-	-	-		

Table 2 - Logistic Regression of factors associated with impairment of nutritional status assessed by mid-upper arm circumference in critically ill children on mechanical ventilation in a Pediatric Intensive Care Unit, between July 2013 and February 2016 (n = 53).

OR: Odds Ratio; CI: Confidence Interval; CCC: Chronic Complex Condition; PIM 2: Pediatric Index of Mortality 2; CRP: Creactive protein; BMI/A: body mass index-for-age; NT: Nutritional Therapy

* assessed at PICU admission; ** average percentage of first 7 days *Adjustment 1: age and PIM 2; **Adjustment 2: age and fluid overload