University Hospital Southampton NHS Foundation Trust

SOUTHAMPTON Children's Hospital

Bioimpedance spectroscopy measurements of phase angle and height for age are predictive of outcome following surgery for congenital heart disease

Magee A G[5], Meyer R[2], Johnson M[3,4], Newell C[4], Johnstone C[1], Sykes K[6], Wootton SA[4], Pappachan JV[6], Marino LV[1]

Department of Dietetics/ SLT, University Hospital Southampton NHS Foundation Trust [1], Department of Paediatrics, Imperial College London[2], Department of Neonatal Medicine, University Hospital Southampton NHS Foundation Trust[3], NIHR Biomedical Research Centre Southampton and University of Southampton[4], Paediatric Cardiology, University Hospital Southampton NHS Foundation Trust[5], Paediatric Intensive Care Unit, University Hospital Southampton NHS Foundation Trust[6].

Background

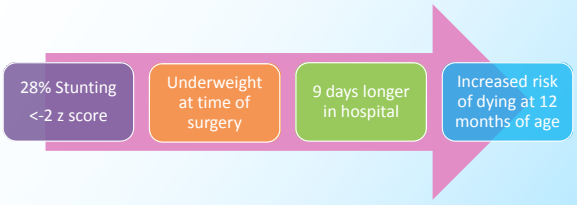
We know that around 28% of infants undergoing cardiac surgery will have a Height for age Z score (HAZ) of < 2. Low HAZ is a measure of dynamic malnutrition.

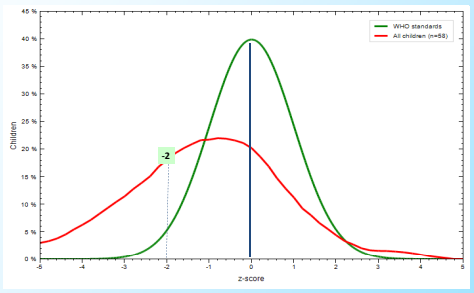
Infants with a poor nutritional status undergoing cardiac surgery tend to have a longer PICU stay and may have an increased risk of dying by 12 months.

Bioimpedance phase angle (BIS-PA) is a prognostic marker associated with increased risk of poorer outcomes-chronic renal disease, oncology, HIV, liver disease, adult critical care. It may therefore be a measure of resilience and cellular integrity.

Objectives

1. To describe the relationship between nutritional status, bioelectrical impedance spectroscopy (BIS) phase-angle and post-operative outcomes.
2. To determine whether serial peri-operative BIS-PA will identify children with poor post-operative resilience who are at risk of prolonged PICU-LOS.



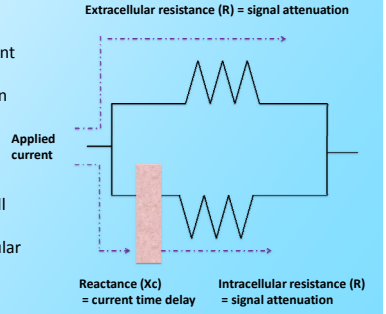


28% of infants had HAZ < -2

BIS – phase angle

BIS – applies a small electrical current passes through the body in a circuit
Resistance – quantity & composition of the tissues & total body water
Reactance – cellular integrity (capacitance)

PA – degree to which there is overall resistance to an electrical current
A lower PA is associated with < cellular integrity – **greater risk – poorer outcomes**



Study population

- ***Data analysis n=117 children***
  - 2 children died - post-operative period with only baseline measures collected
  - BIS-PA measured failed to record in n=3
  - BIS – PA measures n=3,636
- ***4 time points;***
  - baseline before surgery (n=109)
  - post-operative day 0 (n=100)
  - post-operative day 2 (n=95)
  - Discharge (n=60)

Statistics

- ROCs were drawn at baseline, post-operative day 0, day 2 & discharge with area under the curves (AUC) were calculated for all of the phase angle
- Optimal cut-off values for phase angle were chosen based on the highest AUC and a *p* value <0.05
- Univariate logistic regression were executed with PICU-LOS as dependent variables & HAZ/ phase angle cut-offs at each of the time points as independent variables
- Models p-value ≤0.05 included in a multivariate regression model, adjusted for age, PIMS-2 score, RACHS-1 and operative procedure, CPB and ACC
- Statistical significance was a *p* value <0.05

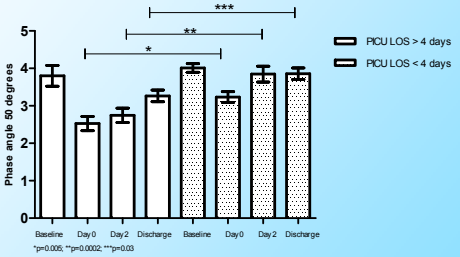
Results

PA cut off values for PICU-LOS

	PICU - LOS	
	Cut off value	**Area under curve, 95% CI**
Baseline phase angle	**2.9**	p=0.008
Post-op day 0 phase angle	**2.9**	p=0.04
Post-op day 2 phase angle	**2.7**	p<0.0001
Discharge from hospital	**2.7**	p=0.03

BIS – PA cut off value < 2.7 day 2 associated with 4 fold increased risk in prolonged PICU-LOS.

Phase angle (50Hz) in children with a length of PICU-LOS > 4 days (n=28) compared to children with a PICU-LOS < 4 days (n=89)



Regression analysis of a low phase angle and HAZ < -2 with duration of PICU-LOS

		Multivariate		
		OR	**95% CI**	**P**
PICU-LOS	**Phase angle day 2 <2.7**	4.5	1.1 -18	0.03
	HAZ <-2	5.2	1.1 – 26.1	0.04

*p≤0.05 Multivariate analyses adjusted for age, risk scores (RACHS-1, PIMS2), duration of operative procedures (AAC, CBP)

Methods

Prospectively enrolled children n=122
- March 2015 – April 2016

BIS spectroscopy
- ImpediMedSFB7 - calibrated before each use
- Baseline, post-op day 0 & 2, discharge
- Measurements in triplicate - mean used in the analysis
- Standard tetrapolar electrodes distribution
- BIS data files processed Bioimp (ImpediMed)
- Data points rejected if:
  - i) positive X centre (Xc) values
  - ii) negative resistance values
  - Phase angle at a current frequency of 50Hz was used for analysis

Anthropometry- moderate malnutrition
- HAZ ≤-2 z-scores below the mean of the WHO child growth standards

Clinical outcomes – definitions
- PICU-LOS ≥ 4 days

Conclusions

1. Moderate malnutrition is common in children undergoing surgery for CHD
2. A phase-angle of < 2.7 at day 2 was associated with a with 4 fold increased risk in prolonged PICU-LOS
3. Changes in bioelectrical impedance spectroscopy (BIS) phase-angle appear to precede anthropometric score in predicting poor PICU outcomes as the mean HAZ score in these children was -1.8 ± 1.5
4. Use of phase angle may promote greater awareness of post-operative risk allowing for better targeting of supplemental nutrition /fluid management in the post-operative period

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