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The impact of fluid balance on muscle mass assessment techniques in ICU patients: Muscle Ultrasound versus Bioelectrical Impedance Analysis

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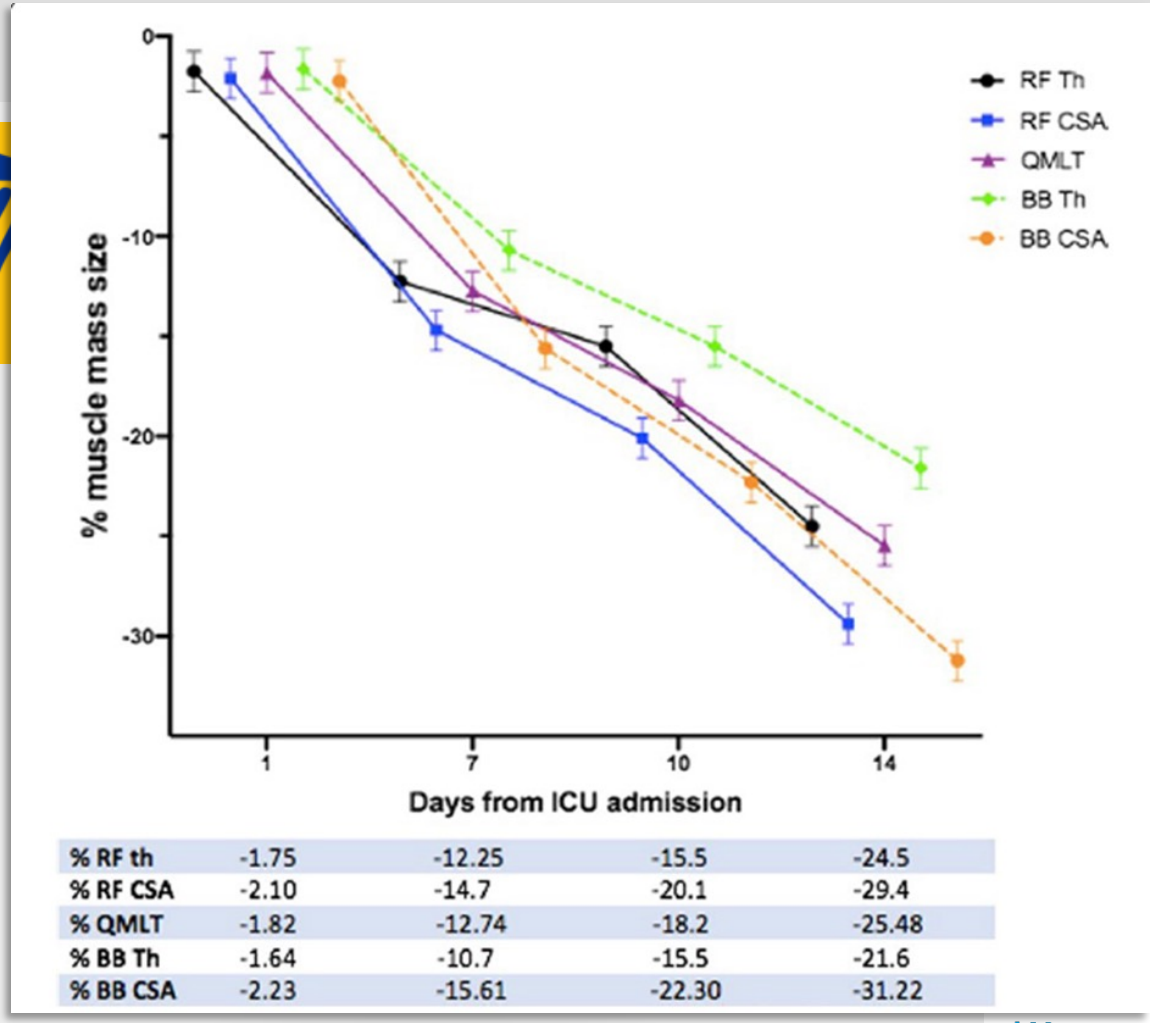
Muscles are an essential source of energy for a critically ill patient

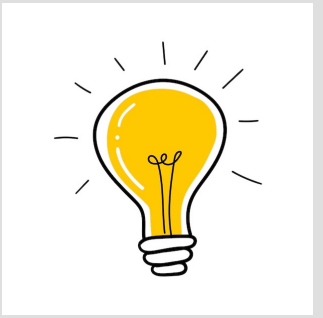
- During the first week in intensive care, more than 10% loss of rectus femoris cross-sectional area was associated with:
  - longer ICU length of stay (p = 0.038)
  - hospital length of stay (p = 0.014)
  - and mechanical ventilation time (p = 0.05)
- In patients with sepsis and acute respiratory distress syndrome, muscle wasting during the first 7 days of ICU was found to be a predictor for ICU-acquired weakness
- The prevalence of ICU-acquired weakness is **48%**



% RF th	-1.75	-12.25	-15.5	-24.5
% RF CSA	-2.10	-14.7	-20.1	-29.4
% QMLT	-1.82	-12.74	-18.2	-25.48
% BB Th	-1.64	-10.7	-15.5	-21.6
% BB CSA	-2.23	-15.61	-22.30	-31.22

Fazzini *et al. Critical Care 2023*

Idea



How could we measure muscle wasting in criticaly ill patiens during treatment in ICU?

- ✓CT?
- ✓BMR?
- ✓DEXA?
- ✓US?
- ✓BIA?
- ✓Anthropometric measurements....?

Methodics

1st day

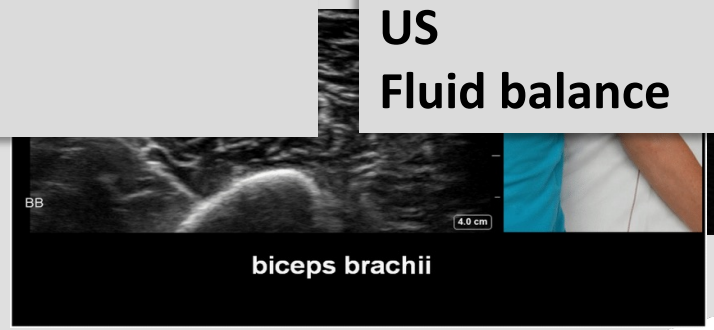
SOFA score
BIA – PhA
US

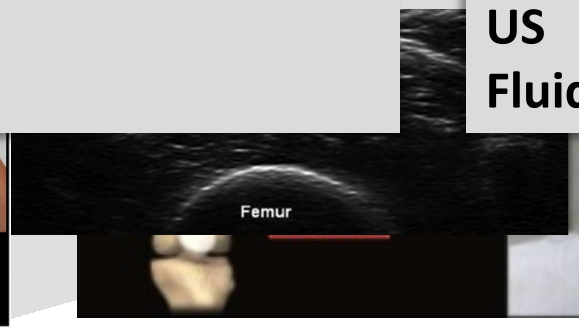
5th day

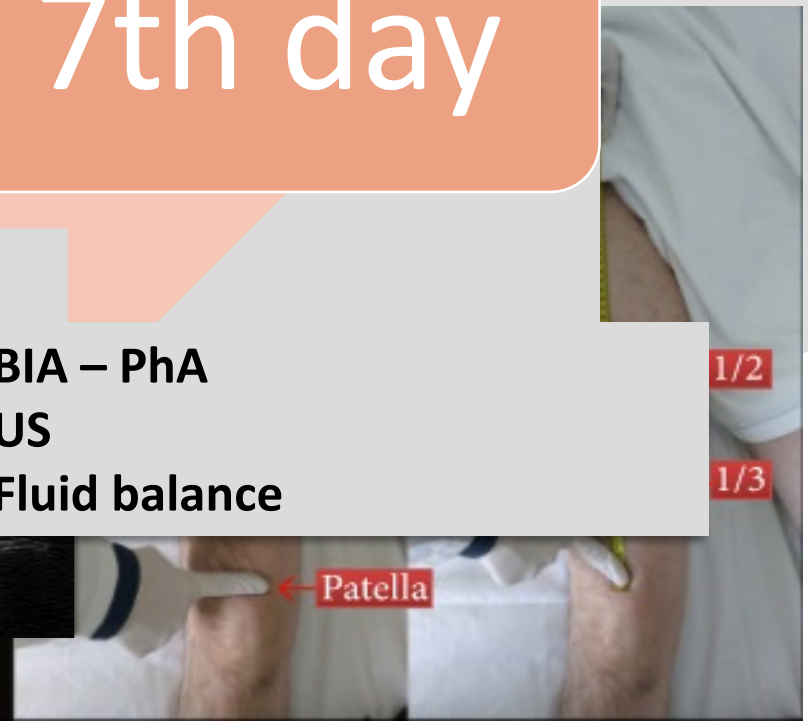
BIA – PhA
US
Fluid balance

7th day

BIA – PhA
US
Fluid balance

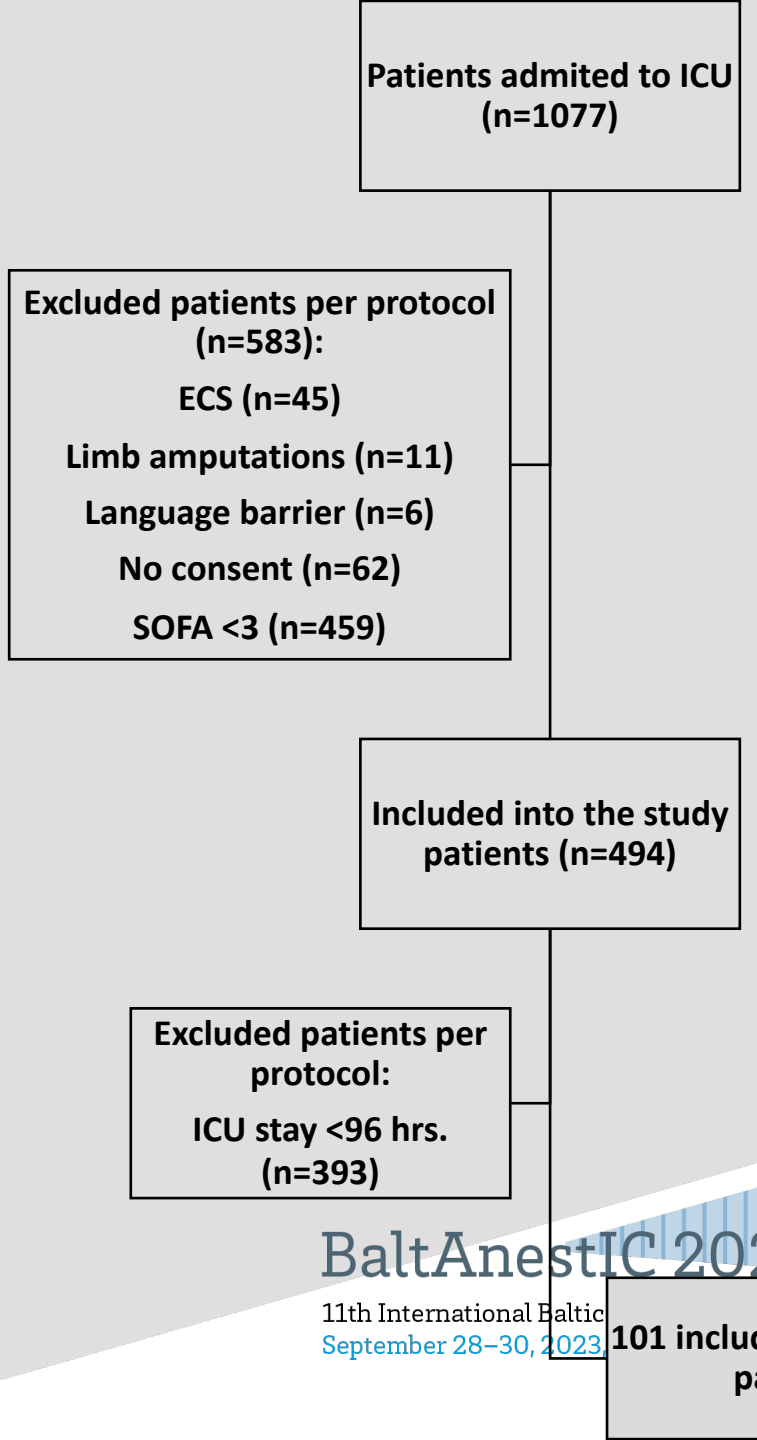






Purpose

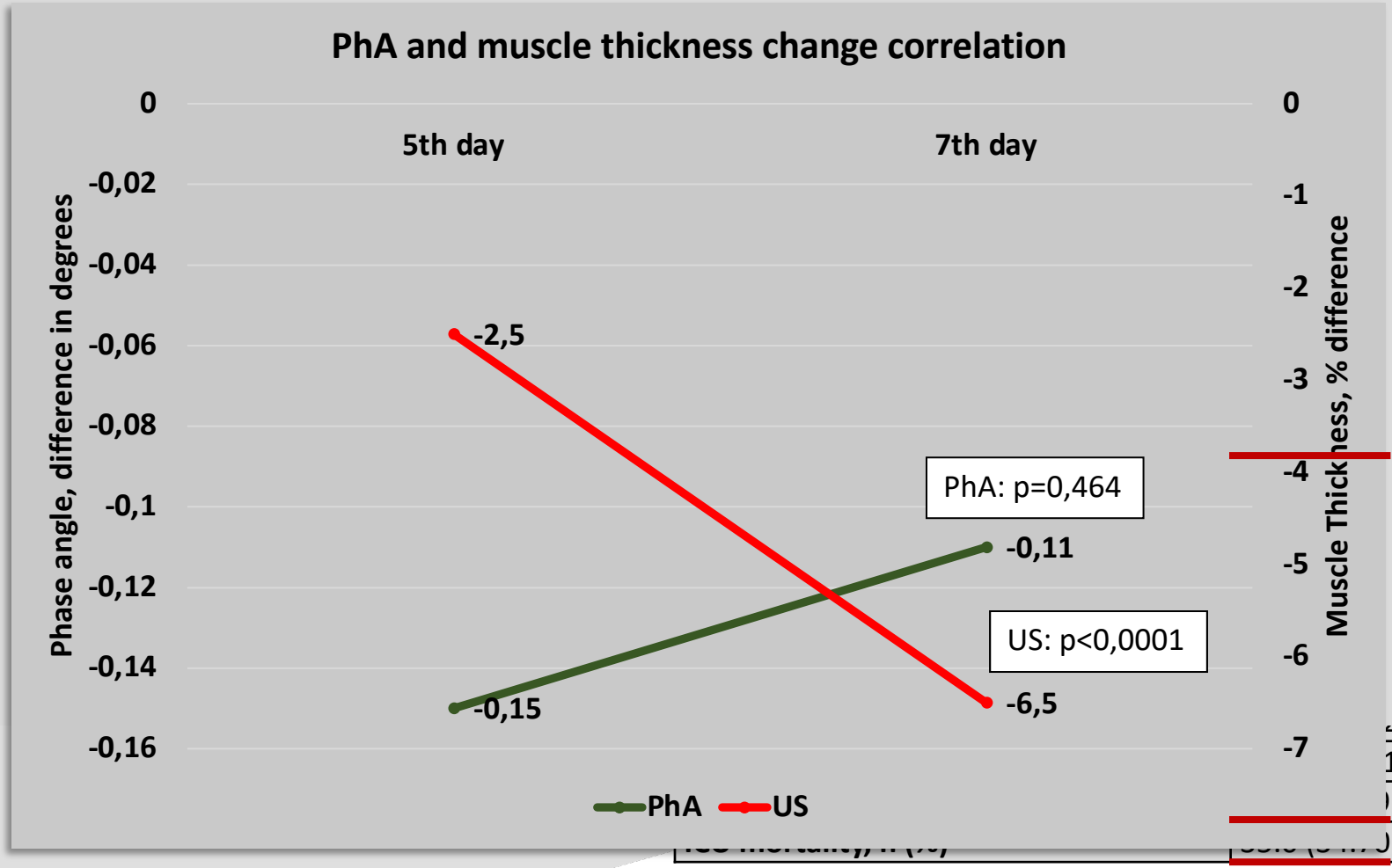
- ✓To compare PhA measured by BIA and muscle thickness measured by ultrasound in detecting and tracking muscle wasting in critical illness
- ✓To assess the impact of fluid balance on these methods in ICU patients



Patients characteristics

Parameter	Per-protocol sample (N = 101)
Age (years), mean (SD)	55.3 (14.81)
BMI (kg/m²), mean (SD)	28.9 (6.24)
Admission type, n (%)	
Medical	57 (56.4)
Surgical	42 (41.6)

Percentage change in muscle thickness does not correlate with the PA change, p=0.14



Which factors affecting both methods?

- ✓PhA is independently influenced by: gender, age, BMI, SOFA score, NRS 2002 score, MV in the first week of treatment, albumin and CRP concentration, fluid balance
- ✓ BMI and fluid balance were found to have significant influence on the phase angle change on 5^{th} and 7^{th} days.
- ✓NRS 2002 score, fluid balance of one week, CRP level and use of renal replacement therapy had significant influence on the relative change in muscle thickness

Fluid balance influence

- ✓More positive fluid balance on the fifth and seventh day of ICU stay has a statistically significantly greater influence on PhA: p<0.001 and p=0.008
- ✓Fluid balance did not have a statistically significant effect on the percentage change in muscle thickness, p=0.4 on day five and p=0.6 on day seventh

	[Min; Q1] [-11420; -320]		(Q1; Q2] (-320; 2495]	
Parameter	N	Mean (SD)	N	Mean (SD)
PhA° change	26	0.39 (0.822)*,**	25	-0.07 (0.717)
FFM % change	26	-1.83 (6.275) *	25	1.95 (12.926)
Biceps brachii % change	26	-4 (11.351)	25	-1.39 (14.291)
Rectus femoris % change	26	-5.43 (11.981)	25	-5.33 (19.214)
Vastus intermedius % change	26	-6.38 (18.711)	25	-4.1 (26.849)
All muscles % change	26	-1.95 (8.888)	25	-5.19 (13.366)

	[Min; Q1] [-13640; -2130]		(Q1; Q2] (-2130; 1650]		(Q2; Q3] (1650; 4935]		(Q3; Max] (4935; 17256]		
Parameter	N	Mean (SD)	N	Mean (SD)	N	Mean (SD)	N	Mean (SD)	P-value
PhA° change	26	0.26 (0.695) *	25	0.09 (0.966)	25	-0.49 (0.637) *	25	-0.3 (1.043)	0.008
FFM % change	26	-5.36 (11.247) *	25	-0.18 (14.587)	25	0.42 (9.938)	25	6.02 (14.01) *	0.019
Biceps brachii % change	26	-5.5 (12.91)	25	-1.32 (12.233)	25	-6.65 (11.455)	25	-4.04 (13.432)	0.472
Rectus femoris % change	26	-8.33 (14.249)	25	-5.67 (22.841)	25	-0.43 (51.675)	25	-1.92 (26.214)	0.809
Vastus intermedius % change	26	-8.87 (25.943)	25	-9.19 (33.131)	25	-4.35 (46.669)	25	-13.47 (29.818	0.834
All muscles % change	26	-3.13 (13.646)	25	-7.25 (11.824)	25	-2.88 (15.187)	25	-3.65 (12.913)	0.631

Conclusions

- ✓Muscle thickness percental difference and PhA do not correlate in the assessment of muscle wasting in the ICU patient
- ✓BIA measurements during ICU stay are significantly influenced by a positive fluid balance
- ✓Muscle ultrasound is more appropriate for evaluation of muscle wasting in our patients during ICU treatment