

## Association of mortality and morbidity with bioimpedance analysis

**To the Editor:** We read with interest the recent article by Ikizler et al demonstrating that, in a 15-month follow-up period, the relative risk of hospitalization determined in 73 unselected hemodialysis (HD) patients increased to 9% and 14% as their reactance ( $X_c$ ) values decreased from 70 ohm to  $X_c = 43$  and  $X_c = 31$  ohm, respectively [1]. With equal interest we read the Letter to the Editor by Piccoli et al, which demonstrated that the  $X_c$  distribution in either healthy or uremic patients is dependent on race-ethnicity, gender, body mass and soft tissue hydration [2]. Piccoli et al demonstrated that low  $X_c$  is found not only in malnutrition patients, but, for example, also in obese HD patients.

We would like to bring our contribution to this debate. Phase angle (PA = the arc tangent of the  $X_c$  to R ratio, R = resistance) captures the relative contributions of  $X_c$  and R. In addition, PA is always the same number as is the result of R and  $X_c$  in absolute values, as both are a result of their normalization for height. Finally, in the obese patients  $X_c$  is low but R is also low, so that PA is normal.

Chertow et al [3] and Maggiore [4] have shown that low PA correlates with mortality in HD patients. In 2767 Italian subjects (males = 1343, females = 1424) with normal body weight, we have elaborated the percentile schedules of normal bioimpedance analysis (BIA) values, divided into gender and age [5]. We used the percentile tables as reference values of BIA measurements effected in an unselected population of 51 patients who have been monitored for the last 5 years (follow-up 2203 months). Quarterly measures with PA < third percentiles in dead patients were 100% in males and 80–100% (according to the varied ages) in females versus 5 to 30% and 5 to 45%, respectively, in males and females living after follow-up [6].

In these same patients we measured the days of the hospitalization (for not surgical motives) for a raw index of morbidity. In Table 1 the results show that both in the males and in the females more days of admission to hospital in the patients with PA < third that in those with PA > third.

It is difficult to provide a plausible explanation for this empirical observation, because the biological meaning of PA is not yet fully understood [4]. Whatever the mechanism, these observations suggest that PA reflects some dimension of the illness that is not fully identifiable with

**Table 1.** Hospitalization (day/patient/year) in hemodialysis (HD) patients with phase angle (PA) <3rd and >3rd percentile values during 5 years of follow-up

Gender	All patients N	<Third percentiles		>Third percentiles		P
		N	Day	N	Day	
Males	30	10	6	20	0.5	0.01
Females	21	8	8	13	0.6	0.01

the deranged nutritional status, which must be important for the prognosis [4].

In conclusion, compared with the usual nutritional parameters, PA appeared to be a better prognostic index of patient morbidity and mortality [4–6].

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### Reply from the authors

Drs. Di Iorio and Bellizzi claim that a reduced phase angle would be a better prognostic index of morbidity and mortality than reactance ( $X_c$ ), since it captures the relative contribution of both  $X_c$  and resistance (R), which would make it insensitive to factors influencing  $X_c$ , like race-ethnicity, gender, body mass, and soft tissue hydration [1].

We maintain that: (1) the same statistical conclusions on the association between body impedance and clinical findings or outcomes are reached utilizing either pair of variables, namely R and  $X_c$ , or magnitude and phase angle of the impedance vector; (2) many conflicting results in the literature are due to univariate analysis of either vector component; and (3) speculations in the