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analyses. Contrary to Abernathy's assertion, smoking is quite unlikely to account for the increased mortality in heavier people because in virtually all studies heavier people have smoked less than thin people.

Although Abernathy would prefer to discard height and weight tables, the excess mortality and morbidity associated with overweight is not eliminated just by dismissing the tables. We concur that long-term weight loss for obese people is seldom achieved. This is all the more reason to have clear and sound weight guidelines that can be used as a criteria for avoiding weight gains as we age. Clearly, the focus must be primarily on prevention of weight gain rather than on treatment after it has already occurred.

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Importance of electrode position in bioelectrical impedance analysis

Dear Sir:

Mayfield et al (1) recently used two reference methods ($H_2{}^{18}O$ and bromide dilution) to demonstrate that resistance and reactance in newborns are correlated with total body water and extracellular water, respectively. This work represents an important step forward in the application of bioelectrical impedance analysis (BIA) in young children because it is the first to propose predictive equations for aqueous body compartments. Unfortunately, these equations can only be used by teams that use the same positions for the four electrodes. However, no standard position has yet been established in young children and it is of great importance to consider this parameter.

The majority of BIA measurements use a tetrapolar system to minimize skin reactions caused by the adhesive electrodes. To measure total body impedance, a pair of electrodes is placed at the extremity of the upper limbs and another pair at the extremity of the lower limbs. Current is applied between the hand- and foot-signal electrodes and the resistance (R) to the current detected between the sensor electrodes of each pair. Because impedance is related to the length of the conductor, the measurement of R is therefore closely linked to the position of the electrode pairs.

In adults the most widely used method uses standard electrode positions on the back of the hands and feet: the signal electrodes are placed on the phalanges and the sensor electrodes just beneath a line between the prominent bones of the wrist and the ankle. This position is such that the sensor electrode is always placed at exactly the same anatomical site and there is always ≥ 5 cm between the two electrodes of the pair. Note that the English Holtain device uses other sites for electrode application in adults: the signal electrode is placed on the wrist and ankle articulation, and the sensor electrodes between 3 and 5 cm farther along the arm and 4 cm along the leg. It is unfortunate that different sites are used because this compromises any attempt to compare R values.

The standard sites used in adults are too close together in young children and can lead to an interaction between the electrodes in each pair. Of the teams that have already published in this field, some have tested different sites (2) or indicated the sites used (1, 3–6), but others have not given any indication of electrode position (7, 8). These studies in children were performed by using different application sites.

In newborns Mayfield et al (1) used the same electrode positions as in adults. The resulting interaction could explain the elevated R values they obtained, which were higher than those we recorded in newborns (A Gartner, P Sarda, RP Dupuy, B Maire, F Delpeuch, D Rieu, unpublished data presented at the Sixth International Congress of Auxology in Madrid, 1991). Mayfield et al report R values > 1000 Ω, which is incompatible within the context of BIA standardization in that the machines used have a measurement range of between 0 and 1000 Ω.

The positioning of the various electrodes has never been tested in newborns. To perform these tests we positioned the electrodes as for adults and added six electrodes side by side on the arm and leg in fixed numbered positions, something that is easier to do in newborns. The electrodes were 1.2 cm wide. The R values we obtained (**Fig 1**) with adult positions (positions 1 and 2) were in the same region as R values obtained by Mayfield et al (1). The farther the selected sensor electrode from the signal electrode, the more R values decreased. The interaction tested with the sensor electrode in position 8 disappeared as soon as the signal electrode moved toward the fingers (Fig 1).

These conclusions were similar to those found by Barillas-Mury et al (2), who performed the same tests in young children. According to them the minimal interelectrode distance is 5.5 cm. A child's hand is not sufficiently large for such a distance to be used and this led to the proposal that electrode application could be extended in young children to the forearm and the leg. Subsequent BIA studies performed by this team in children used a distance of 6 cm from the signal electrodes placed on the wrist and ankle articulations (5, 6). This is the site that we used recently for the study in newborns.

Two BIA studies in young children (3, 4) were performed with the signal electrode placed in the adult position on the phalanges and the sensor electrode 3 or 4 cm farther along the hand and the foot. The authors found that a minimal distance of 3 cm was necessary (3) but they used a test that, to us, seems unclear. The effect of electrode position on the measurement of R was tested by increasing the distance between the fixed-signal electrode and the mobile-sensor electrode by steps of 0.5 cm. The results (expressed as a percentage of the smallest value measured) showed that a plateau was reached. However, in such a test in which the sensor electrode is moved, R decreases continuously and the smallest value measured is that obtained with the largest distance tested. It is not possible to obtain a plateau under these conditions.

Growth references from the National Center for Health Statistics and the Centers for Disease Control are currently being revised and the measurements planned include BIA in children aged ≥ 12 y (9). It is therefore important to define electrode position in this case so that measurements performed today can be compared with the future reference.

In conclusion, electrode position, and above all the position

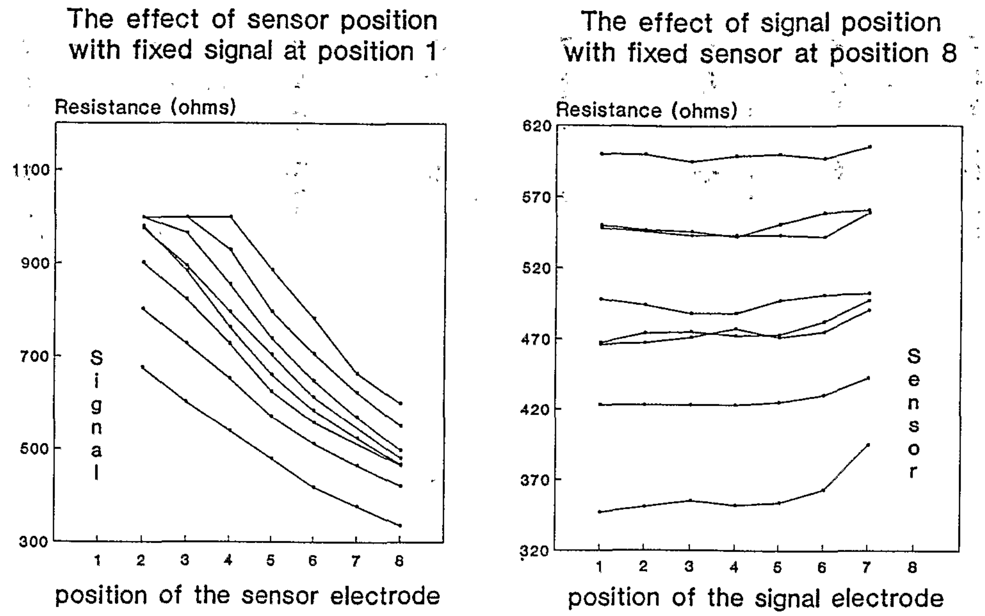

FIG 1. Effect of electrode position on bioelectrical impedance analysis measurement in newborns. Resistance was measured by using an AKERN (Firenze, Italy) analyzer. Positions 1 and 2 correspond to the standard positions in adults. The other positions correspond to electrodes (1.2 cm wide) placed side by side along the arm or leg from position 2 and above. The sensor electrode at position 8 was 6 cm from position 2. The value 999 Ω is the maximum of the machine.

of the sensor electrode, is one of the most critical factors in BIA measurements. Standard electrode positioning must at least describe an anatomic site for one of the electrodes and the precise distance that separates the electrodes within each pair. To date, a small number of BIA studies in young children have been published but with large variations in electrode position. Standard electrode positions in young children have now become indispensable. Studies should be performed to test and compare possible sites and result in the definition of a single standard.

This step forward in the application of BIA measurements in young children is indispensable to allow R values to be compared and thus lend more weight to the results obtained and increase interest in studies using BIA in young children.

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No reply was received from SR Mayfield.