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# INTRACELLULAR WATER IN MAN<sup>1</sup>

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Measurements of intracellular water, calculated as the difference between the volumes of distribution of antipyrine and inulin, have been reported by Berger and associates (1) in four patients with chronic disease. Comparable data are not available on normal subjects and the present study was undertaken to make such data available.

## METHODS

Total body water was determined as the volume of distribution of antipyrine,<sup>2</sup> corrected for the amount metabolized, by the method of Soberman and co-workers (2). Soberman and his associates report good agreement in this measurement as made with antipyrine and with deuterium oxide in six normal males. However, these investigators assumed that maximal distribution of antipyrine was reached in two hours and they consequently used the plasma concentrations determined at two, three and five hours for extrapolation to zero time in correcting for metabolism. In view of the fact that sucrose, which is confined to the extracellular fluid, may not reach maximal distribution in two hours in some non-edematous subjects (3), we have preferred to base our extrapolation on the plasma concentration at three, four and five hours, and, where possible, to include the concentration at seven or eight hours.

Extracellular fluid was measured by the maximal volume of distribution of sucrose as determined by the calibrated infusion technique (3). Intracellular water was determined as the difference between the antipyrine and sucrose volumes of distribution. Cellular mass was calculated as the difference between body weight and sucrose volume of distribution.

The subjects were patients ranging in age from 13 to 60 years who had been hospitalized for elective surgery or routine physical examination.

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<sup>2</sup> The antipyrine used in these studies was supplied in ampoule form by Eli Lilly and Company, Indianapolis 6, Indiana.

## RESULTS AND DISCUSSION

Table I presents the simultaneous measurements of total body water and extracellular fluid in 11 male subjects. Calculated values for the volume of intracellular water, intracellular water as per cent of body weight, intracellular water as per cent of body water, and intracellular water as per cent of cellular mass, are indicated for each subject. Intracellular water averaged 40.6 per cent of body weight (range 34.7 to 48.0) and 70.2 per cent of total body water (range 64.9 to 74.5). Water comprised on the average 50.3 per cent (range 41.8 to 59.6) of cellular mass.

In the six males studied by Soberman and his co-workers (2) the average antipyrine and deuterium oxide space was 54.6 and 55.8 per cent, respectively, of the body weight. Steele and colleagues (4) report the average antipyrine space as 52.7 per cent of body weight in 51 normal males, while Schloerb and associates (5) report the average deuterium oxide space as 61.8 per cent of the body weight in 18 normal males. Our antipyrine figure based on 11 males is 58.1 per cent (range 51.8 to 64.5), a figure that is in better agreement with the deuterium oxide data cited above. We believe that our figure is higher than that reported by Steele and co-workers (4) because we have neglected the two hour plasma concentration in favor of concentrations from three to eight hours.

Schwartz, Schachter and Freinkel (6) have reported an average inulin space of 16.3 per cent of body weight in six males. The sucrose space in the present series of 11 males averages 17.5 per cent of body weight. This agreement supplements the data previously presented (3) that sucrose and inulin are restricted to a similar fluid compartment.

Intracellular water in the four patients studied by Steele and his co-workers (4) averaged 40.7

TABLE I  
*Intracellular water in 11 male subjects*

| Patient | Age | Height | Weight | Total body water |                      | Extracellular fluid |                      | Intracellular water |                      |                     |                    |
|---------|-----|--------|--------|------------------|----------------------|---------------------|----------------------|---------------------|----------------------|---------------------|--------------------|
|         |     |        |        | liters           | per cent body weight | liters              | per cent body weight | liters              | per cent body weight | per cent body water | per cent cell mass |
| C. E.   | 22  | 71     | 73.6   | 44.8             | 60.8                 | 14.1                | 19.1                 | 30.7                | 41.7                 | 68.5                | 51.6               |
| A. M.   | 41  | 72     | 84.5   | 43.7             | 51.8                 | 14.4                | 17.1                 | 29.3                | 34.7                 | 67.0                | 41.8               |
| R. M.   | 58  | 72     | 85.0   | 47.4             | 55.8                 | 16.7                | 19.6                 | 30.7                | 36.1                 | 64.9                | 45.0               |
| J. T.   | 13  | 54     | 37.2   | 20.3             | 54.6                 | 5.2                 | 14.0                 | 15.1                | 40.6                 | 74.5                | 47.2               |
| K. O.   | 43  | 67     | 69.6   | 38.4             | 55.3                 | 11.3                | 16.2                 | 27.1                | 39.0                 | 70.6                | 46.5               |
| T. E.   | 36  | 68     | 77.0   | 49.6             | 64.5                 | 12.6                | 16.3                 | 37.0                | 48.0                 | 74.5                | 57.5               |
| T. G.   | 36  | 73     | 88.4   | 53.4             | 60.2                 | 14.3                | 16.2                 | 39.1                | 44.3                 | 73.5                | 52.8               |
| R. M.   | 29  | 69     | 70.5   | 42.7             | 60.5                 | 10.9                | 15.5                 | 31.8                | 45.1                 | 74.4                | 59.6               |
| H. C.   | 60  | 68     | 74.1   | 45.5             | 61.4                 | 13.9                | 18.8                 | 31.6                | 42.6                 | 69.5                | 52.5               |
| L. C.   | 14  | 60     | 44.3   | 25.0             | 56.4                 | 8.7                 | 19.7                 | 16.3                | 36.8                 | 65.1                | 45.8               |
| W. J.   | 30  | 63     | 64.1   | 37.4             | 58.2                 | 12.5                | 19.5                 | 25.9                | 38.7                 | 69.1                | 50.2               |
| Average |     |        |        |                  | 58.1                 |                     | 17.5                 |                     | 40.6                 | 70.2                | 50.3               |
| Range   |     |        |        |                  | 51.8<br>to<br>64.5   |                     | 14.0<br>to<br>19.7   |                     | 34.7<br>to<br>48.0   | 64.9<br>to<br>74.5  | 41.8<br>to<br>59.6 |

per cent of body weight (range 29.3 to 47.0), as compared with an average of 40.6 per cent (range 34.7 to 48.0) in this study.

#### SUMMARY

Total body water and extracellular fluid have been measured simultaneously by the antipyrine method and the calibrated sucrose infusion technique in 11 normal male subjects. Intracellular water has been calculated as the difference between total body water and extracellular fluid.

Intracellular water averages 40.6 per cent of body weight (range 34.7 to 48.0), 70.2 per cent of total body water (range 64.9 to 74.5) and 50.3 per cent of cellular mass (range 41.8 to 59.6).

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