

11. Folch, J., Lees, M. and Sloane-Stanley, G. H., *J. Biol. Chem.*, 1957, 226, 497.
12. Ames, B. N., *Methods in Enzymology*, (Academic Press, Inc., New York), 1966, 8, 115.
13. Butler, W. M., *Amer. J. Pathol.*, 1966, 49, 113.
14. Gustafsson, R. G. and Afzelius, B. A., *J. Natl. Cancer Inst.*, 1963, 30, 1045.
15. Williams, D. J. and Rabin, B. R., *Nature (London)*, 1971, 232, 102.
16. Purchase, I. F. H., Longstaff, E., Ashby, J., Styles, J. A., Anderson, D., Lefevre, P. A. and Westwood, F. R., *Br. J. Cancer*, 1978, 37, 873.

RED-CELL 2,3-DIPHOSPHOGLYCERATE AND POTASSIUM HOMEOSTASIS IN THYROID DISORDERS

In a recent issue of your journal, Sarkar *et al.*¹ report the finding of a significant rise in the potassium content of plasma and red cells, with simultaneous increase in the erythrocyte 2, 3-diphosphoglycerate (2, 3-DPG) concentration in hyperthyroid rats.

In 21 female patients, aged between 18 and 67 years (mean \pm SD : 48 ± 14 years), with clinical as well as hormonal evidence of hyperthyroidism, (whom we studied on 29 occasions), we also found abnormally high levels of 2,3-DPG, which could not be accounted for by alterations in the haematocrit (Hct), haemoglobin (Hb) or serum inorganic phosphate (P) levels². The 2,3-DPG increase however, did show in our cases a significant correlation ($p > 0.05$) with the serum thyroid hormones (serum total T3 and T4). Hct, Hb and P were determined by standard haematological techniques, while determinations of red cell 2,3-DPG were performed by Eaton *et al.*³ modification of Bartlett's⁴ chromotropic acid (4,5-dihydroxy-2,7-naphthalene-disulfonic acid) method. Hormone concentrations were measured by means of the Abbott Laboratories radioimmunoassay kits (normal ranges : 100–210 ng/dl and 5–13 μ g/dl for T3 and T4 respectively). Although we did not include the estimates of the plasma potassium content (K) (determined photometrically) in the mentioned work, at the same time as our 21 hyperthyroid patients were analysed for 2,3-DPG, Hct, Hb, P, T3 and T4 levels an analysis of K was made for 16 of them, using the same blood samples. Our findings in these 16 patients as well as those in euthyroid control subjects are shown in Table I. Increased levels of 2,3-DPG (6.01 ± 0.78 mM) are present in these female patients and show a clear statistical difference with the levels in the euthyroid control series ($p > 0.001$). In both groups, however, K appears to be largely similar and within normal limits. We have also been unable to establish any relevant correlation between the red-

cell, 2,3-DPG concentration and the potassium content of plasma.

TABLE I

Haematological and thyroid function data in patients with hyperthyroidism and in euthyroid controls. Values shown are mean \pm SD with SEM in brackets.

	Hyperthyroid (N = 16)	Euthyroid (N = 32)
Age (years)	48 ± 14 (3.6)	51 ± 14 (2.5)*
Hb (g/dl)	13.6 ± 1.4 (0.3)	14.0 ± 0.8 (0.1)*
Hct (%)	40.8 ± 5.4 (1.3)	41.7 ± 2.9 (0.5)*
P (mg/dl)	3.2 ± 0.4 (0.1)	3.4 ± 0.5 (0.08)*
T3 (ng/dl)	327 ± 126 (32)	139 ± 26 (4.6)**
T4 (μ g/dl)	16.7 ± 6.3 (1.6)	9.3 ± 1.7 (0.3)**
K (mEq/l)	4.24 ± 0.33 (0.08)	4.20 ± 0.33 (0.05)*
2,3-DPG (mM)	6.01 ± 0.78 (0.2)	4.89 ± 0.50 (0.08)**
2,3-DPG μ moles/g Hb)	17.9 ± 2.5 (0.6)	15.0 ± 1.5 (0.2)**

(N = number of experiments; * not significant; ** $p < 0.001$).

Our results in human patients are not in agreement with those reported by Sarkar *et al.*¹, regarding the homeostasis of potassium in hyperthyroid situations. In any event, it should be borne in mind that the findings of the authors mentioned may not be entirely at variance with ours, owing to the induced nature of the disorder and the fact that male rats were used whereas our subjects were all women, who had developed the hyperthyroid state spontaneously.

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April 28, 1980.

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1. Sarkar, S. R., Singh, L. R., Banerji, R. and Chaudhuri, B. N., *Curr. Sci.*, 1979, 48, 880.
2. Alvarez-Sala, J. L., Urbán, M. A., Sicilia, J. J., Diaz Fdez, A. J., Fdez Mendieta, F. and Espinós, D., *Acta Endocrinol.*, 1980, 93, 424.
3. Eaton, J. W., Brewer, G. J., Schultz, J. S. and Sing, C. F., In *Red Cell Metabolism and Function*, Brewer, G. J., Plenum Press, New York, 1970, p. 21.
4. Bartlett, G. R., *J. Biol. Chem.*, 1959, 234, 469,