treatment of conditions associated with overgrowth or neoplastic processes in the lymphoid tissues. Experiments in the transplantation of neoplastic tissues in rats either adrenalectomized or treated with ACTH or adrenal cortical substances by Murphy and Sturm[8] give further support to the hypothesis that these tissues are under the hormonal influence of the adrenal cortex.

Summary. IP injection of adrenocorticotrophic hormone (ACTH) in the rat produces a transient leukopenia with decrease in number of lymphocytes and increase in the number of circulating neutrophils. Intraperitoneal injection of ACTH in the normal dog produces a marked neutrophilic leucocytosis which is qualitatively similar to but quantitatively greater than that produced by injection of other anterior lobe substances. Subcutaneous injection of ACTH in the dog produces a lymphopenia which is similar to that occurring in the rat after treatment with ACTH.

[8] Murphy, J. B., and Sturm, E., *Science*, 1943, **98**, 568; 1944, **99**, 303.

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Gravity Shock in Rabbits. III. Changes in Distribution of Phosphate and Chloride in Blood and Urine.

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The significant chemical changes occurring in the blood of rabbits suspended by their ears until unconsciousness occurs are: decreased blood pH, CO_2, venous O_2, increased blood lactate, pyruvate, plasma potassium, inorganic phosphate and non-protein nitrogen. Urine flow falls to zero or nearly so. The changes are considered to be the result of hypoxia caused by peripheral circulatory deficiency.[1,2] To determine in part the source of the phosphate and whether or not a change in the chloride ratio occurs, studies have been made on the distribution of phosphorus and chloride in cells and plasma, and on the excretion of urinary phosphate in rabbits before, during, and recovering from gravity shock.

Methods. The animals used and the methods of producing shock, of withdrawing blood samples, of measuring pH, hematocrit and chloride content have been previously described.[2] Inorganic and acid-soluble phosphorus were determined by the Fiske and Subarrow method as modified by Guest and Rapoport.[3] Samples of blood were drawn just before suspension, just after unconsciousness, and from one to 2 hours after the animals had been returned to the horizontal position.

Results. The hematocrit during shock did not change consistently, but during recovery always decreased (Table I). Whether or not the rabbits had been fed preceding the experiment, the plasma and red cell inorganic phosphorus increased during shock, and was roughly correlated with the decrease in blood pH. The organic acid-soluble phosphorus in plasma usually increased during shock but in the cells it fluctuated around the control values. During recovery the plasma phosphorus compounds and the cell inorganic phosphorus tended to shift back towards control values, but the cell organic acid-soluble phosphorus increased significantly above control levels. Evidently the added inorganic phosphorus was not derived from food in the

* For assistance in collecting the data on urine flow and urine phosphate determinations, we are indebted to Martin J. Jarvis.

[1] Cole, W. H., Allison, J. B., and Boyden, A. A., PROC. SOC. EXP. BIOL. AND MED., 1943, **54**, 215.

[2] Cole, W. H., Allison, J. B., Murray, T. J., Boyden, A. A., Anderson, J. A., and Leathem, J. H., *Am. J. Physiol.*, 1944, **141**, 165.

[3] Guest, G. M., and Rapoport, S., *J. Biol. Chem.*, 1938, **124**, 599.

TABLE I.

The Hematocrit and pH of the Blood, and the Distribution of Inorganic and Organic Acid-soluble Phosphorus in Red Blood Cells and Plasma of Rabbits Before, During and After Gravity Shock. Animals numbered 1, 2, and 5 died in shock. Animals which received no food 24 hours previous to gravity shock are indicated by an asterisk before the number in the first column.

				Phosphorus—mg/100 ml			
				Plasma		Red blood cells	
Animal No.	State	pH	% red blood cells	Inorg.	Organic acid-soluble	Inorg.	Organic acid-soluble
1	Control	—†	37.0	5.6	0.7	2.77	86.2
	Shock	6.68	37.1	14.3	2.80	6.41	90.3
2	Control	—	41.8	7.15	0.85	2.24	93.4
	Shock	6.58	45.2	24.6	4.20	13.7	88.0
3	Control	—	42.6	3.30	—	2.34	81.3
	Shock	7.23	41.8	5.20	0.68	2.67	80.3
	Recovery	7.39	36.1	3.90	0.90	1.0	91.4
*4	Control	—	42.5	5.98	0.42	3.03	89.8
	Shock	7.25	43.0	8.00	8.60	5.44	90.4
	Recovery	—	33.3	9.15	0.35	3.45	98.4
*5	Control	—	51.1	5.68	0.12	2.64	75.0
	Shock	6.85	47.7	16.40	0.0	8.63	94.9
*6	Control	—	41.4	6.42	0.78	2.34	70.8
	Shock	7.20	40.3	11.63	0.40	8.84	76.3
	Recovery	7.31	27.8	9.22	0.58	5.18	79.1
*7	Control	—	41.2	6.12	0	2.57	74.1
	Shock	7.15	42.8	12.20	2.6	8.41	68.7
	Recovery	7.35	30.8	9.13	1.77	3.28	85.0

† The control pH was assumed to be 7.33 which was the average of determinations on 28 different control animals in a previous series.[2]

TABLE II.

The Hematocrit and pH of the Blood, and the Distribution of Chloride Ions Between Red Blood Cells (c) and Plasma (p) Before (Control) and During Gravity Shock (Shock).

Animal No.	State	pH	% red cells	Plasma chloride meq./l	Cell chloride meq./l	Cl_c/Cl_p
1	Control	—	37.2	109.0	74.0	0.68
	Shock	7.06	36.2	110.0	79.6	0.72
2	Control	—	47.5	110.8	61.7	0.56
	Shock	6.72	51.8	95.7	79.9	0.83
3*	Control	—	42.6	107.2	54.4	0.51
	Shock	7.23	41.8	104.4	60.6	0.58
	Recovery	7.39	36.1	108.6	59.3	0.55
4	Control	—	47.5	110.8	59.8	0.53
	Shock	6.98	46.1	101.8	61.2	0.60
5	Control	—	41.6	114.9	50.9	0.44
	Shock	6.90	45.2	109.8	89.5	0.82

* The same animal as No. 3 in Table I.

alimentary canal nor from organic acid-soluble phosphorus in the red cells.

The plasma chloride did not change significantly or decreased slightly during shock,

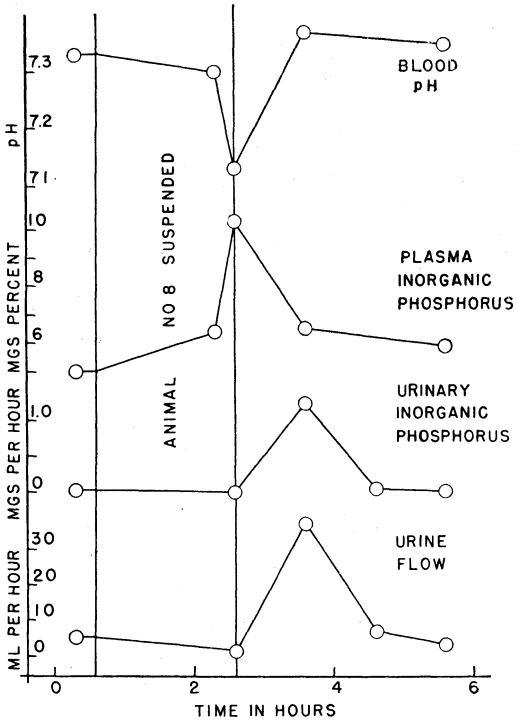

FIG. 1.

Changes in blood pH, concentration of plasma inorganic phosphorus, urine flow and total inorganic phosphorus excreted in urine per hour in a rabbit suspended for 2 hours and then returned to horizontal position. Period of suspension is indicated by the 2 vertical lines.

whereas the cell chloride definitely increased (Table II). The net result was always an increased ratio of cell chloride to plasma chloride. Since water in the cells and plasma was not determined, it cannot be decided whether the altered ratio was caused only by a chloride shift. Increase in the ratio was greater in the animals with a blood pH of 6.9 or less.

The effects of gravity shock and of recovery processes on urine flow and excretion of inorganic phosphorus as correlated with blood pH and plasma inorganic phosphorus are illustrated in Fig. 1. Four other animals gave the same kind of results, although in the majority of them decrease in plasma inorganic phosphorus and increase in urine flow during recovery were not as large as shown in No. 8. The data support the concepts that oliguria or anuria contribute to the development of the metabolic conditions associated with shock and that increased kidney function aids in the recovery from those conditions.

Discussion. It is assumed that the phosphatemia of gravity shock results from the breakdown of creatine and other organic phosphates in the tissues during stagnant hypoxia. The ratio between inorganic and organic phosphorus is thus increased. The simultaneous increases in blood lactate and pyruvate, so that the lactate-pyruvate ratio is increased, reflects the depletion of glycogen stores during hypoxia. Prolongation of that state results in depletion of adenyl pyrophosphate and phosphorylated enzymes, leading to a breakdown of normal metabolism. The large increase in plasma inorganic phosphate thus produced tends to reverse by mass action the liberation of inorganic phosphorus from the cell organic phosphates which is favored by the decreased blood pH.[4] The increased phosphate concentration in the cells probably replaces part of the bicarbonate which decreases because the pH and the CO_2 content of whole blood decreases.[2] The new cell-plasma equilibrium is reflected by the increased chloride ratio. Conversion of inorganic into organic phosphorus is favored during recovery as the pH returns to normal, accompanied by increased urinary excretion of inorganic phosphate, so that the phosphatemia disappears.

Summary. The increased inorganic phosphate in plasma during gravity shock does not originate from food in the digestive tract nor from the organic acid-soluble phosphorus in the red cells. The chloride ratio increases during gravity shock. During recovery diuresis and phosphaturia occur, while the pH, plasma phosphate, and chloride ratio rapidly return to control values. If those five processes do not occur the animal will die.

[4] Guest, G. M., and Rapoport, S., *J. Lab. and Clin. Med.*, 1940-41, **26**, 190.