A STUTY OF EXTRA-CELLULAR FLUID COMPARTMENTS DURING HYPERTHERMIA IN DEHYDRATED DOGS

By

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The thiocyanate space and plasma volumes were determined at rising body temperatures in dogs dehydrated by fluid deprivation for 48 hrs. It was observed that dehydration produces loss of fluid both from the plasma and the tissue spaces, with a relatively greater loss from the later During hyperthermia fluid was added to the extra-cellular compartments but the gradient was more towards the plasma than tissue spaces. The possible source of this additional fluid has been discussed. Saline transfusion during hyperthermia in such dogs results in the distribution of the fluid first in the extra-cellular compartments and then possibly into the intra-cellular space also.

It has been shown by Kumar and Lahiri (1962) that on raising the body temperature of the normal dogs there occurs an increase in the extra-cellular fluid. This excess fluid first appears in the plasma and is then subsequently spread out to the tissue spaces also. It was now proposed to study the fluid shifts in dehydrated dogs under similar conditions.

METHODS

The experiments were conducted on 14 healthy dogs of both sexes weighing between 6 kg to 12·5 kg. They were deprived of all fluids for 48 hrs and were fed on dry bread during this period. Since these experiments were done during the summer months of August and September, in this period the water deprivation was enough to produce sufficient dehydration as evidenced by their completely dry tongue and their urge to accept water readily if offered. They were anaesthetised with chloralose 80 mg/kg body weight given intravenously. The methods for raising their body temperature and estimation of extra-cellular fluid and plasma volume were the same as described earlier (Kumar and Lahiri, 1962).

RESULTS

It was observed that dehydrated dogs did not bear hyperthermia as well as did the normal dogs, and died when their body temperature was raised above 41°C. Intravenous injection of 250 to 300 ml of normal saline had

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therefore, to be given at about this temperature to delay death. The results are given in Tables I and II.

DISCUSSION

When the above observations on the various fluid compartments of the body in dehydrated dogs are compared with those of the normal dogs reported earlier (Kumar and Lahiri, 1962) it was observed that at 38°C body temperature the resting mean ECF decreased from 369 to 308 ml/kg body weight. The interstitial fluid and plasma volumes also decreased from 316 ml and 49 ml to 248 ml and 43 ml/kg body weight respectively. Thus during dehydration fluid was lost both from the tissue spaces as also from the plasma. The plasma to tissue fluid ratio increased to 0·17 from 0·15 observed in normal dogs at 38°C body temperature, thus indicating that during dehydration relatively more fluid was lost from the tissue spaces than from the plasma.

On raising the body temperature of these dehydrated dogs there occured an increase in all the fluid compartments of the extra-cellular space (Tables I and II) and the distribution of the fluid as in normal dogs, was both in the plasma and in the interstitial tissue fluid with a relative gradient more towards the former than later. The increase in the blood volume per killogram body weight was almost completely due to an increase in plasma volume alone.

TABLE I

Extra-cellular fluid per kg body weight at rising body temperature

Do no.	38°C	39°C	40°C	41°C
1	—	365	365	365
2	333	—	333	347
3	—	293	335	322
4	—	294	294	333
5	—	276	289	—
6	280	—	291	297
7	—	318	318	330
8	304	—	318	333
9	387	464	516	464
10	271	271	271	271
11	299	312	312	316
12	—	280	290	271
13	—	324	310	364
14	282	282	296	296
Mean	308	316	323	332

TABLE II

Blood (Bl), plasma (Pl) and tissue fluid (Tf) volumes per kg body weight at rising temperatures

Dog no.	Before saline																After saline							
	38°C				39°C				40°C				41°C				41.5°C				42°C			
	Bl	Pl	Tf	Pl/Tf	Bl	Pl	Tf	Pl/Tf	Bl	Pl	Tf	Pl/Tf	Bl	Pl	Tf	Pl/Tf	Bl	Pl	Tf	Pl/Tf	Bl	Pl	Tf	Pl/Tf
1	—	—	—	—	80	48	317	0.15	73	45	320	0.14	73	45	320	0.14	—	—	—	—	92	60	327	0.18
2	—	—	—	—	—	—	—	—	—	—	—	—	111	62	285	0.21	191	111	273	0.40	—	—	—	—
3	—	—	—	—	82	46	247	0.19	—	—	—	—	80	46	276	0.17	86	48	291	0.16	99	57	282	0.20
5	—	—	—	—	62	36	236	0.15	—	—	—	—	—	—	—	—	73	43	283	0.15	85	51	263	0.20
6	72	40	240	0.17	—	—	—	—	76	42	249	0.16	75	42	255	0.16	75	43	275	0.16	—	—	—	—
7	—	—	—	—	97	53	265	0.20	101	57	261	0.22	107	60	270	0.22	110	63	287	0.22	—	—	—	—
8	63	37	267	0.14	—	—	—	—	65	38	280	0.14	68	40	293	0.14	—	—	—	—	69	41	324	0 12
11	97	52	247	0.21	—	—	—	—	95	52	260	0.20	—	—	—	—	111	61	275	0.22	—	—	—	—
12	—	—	—	—	81	45	235	0.19	99	53	237	0.22	107	58	213	0.27	—	—	—	—	134	69	226	0.30
14	81	44	238	0.18	81	44	238	0.18	86	47	249	0.19	94	51	245	0.21	—	—	—	—	107	63	248	0.25
Mean	78	43	248	0.17	80	45	256	0.17	85	47	265	0.18	89	50	269	0.19	107	61	280	0.21	98	57	278	0.20

What could be the source of the extra fluid that appears in the ECF? Obviously it could not be the one absorbed from the gastro-intestinal tract as the dogs were water starved for 48 hrs preceeding the start of the experiment. As for the metabolic source of water it has been reported that in human beings 300 to 350 ml of water is formed every day (Best and Taylor, 1961). This comes to 4 to 5 ml of water kg/day. The corresponding figures for the dog were not available to the authors. Since the fluid entering the ECF during hyperthermia is very much higher than even the figures for the metabolic water in human beings it is unlikely that the metabolic water could be the source of increase in ECF. It is suggested that the source is the intracellular water itself. This needs elucidation by further experiments.

On intravenous injection of normal saline at about 41°C body temperature, the fluid distributed both to the plasma and the interstitial tissue spaces and at 41·5°C body temperature relatively more fluid was present in the plasma than in the tissue spaces. When the temperature was raised to 42°C the fluid left the ECF compartments, possibly going back into the cells from which it was made available when the body temperature was raised. With saline transfusion, the total blood volume also increased and this increase was due both to increase cell and plasma volumes. It appears that for extra cells to be thrown in active circulation a certain amount of plasma volume is necessary and that was made available to the dehydrated dogs on intravenous saline transfusion.

REFERENCES

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