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OBSERVATIONS ON THE HEART RATE IN VITAMIN B_1 AND C DEFICIENCY.

BY

G. SANKARAN

AND

B. G. KRISHNAN.

(*Nutrition Research Laboratories, I. R. F. A., Coonoor, S. India.*)

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DRURY *et al.* (1930) reported that bradycardia was a regular symptom of vitamin B_1 deficiency in pigeons and rats, and that administration of vitamin B_1 concentrates cured this symptom. Birch and Harris (1934) made use of this fact to elaborate a technique for estimating the vitamin B_1 content of food-stuffs, the rat being the experimental animal. As the method described is less time consuming than most other biological methods used for vitamin B_1 estimations, a study of it was undertaken in these laboratories. Our first step was to obtain electrocardiographic records of heart rate in pigeons and rats, fed on complete and vitamin B_1 deficient diets.

METHOD.

The cardiograph used was a portable Matthew's inkwriter electrocardiograph which, as the name indicates, makes a record in ink on a reel of paper. The makers provide a special celluloid transparent time scale for reading the record. The electrodes are hypodermic needles electrically connected to the lead wires of the cardiograph, and are inserted under the skin of the animal. The pigeon is laid on its back and two sand bags are laid across the outstretched wings while another is placed over the legs. Two needles are inserted under the lower surface of the wings close to the body, while a third is inserted under the skin of the left thigh. Tracings of all the three leads were obtained but usually one lead—as a rule the second—was convenient for study. While the cardiograph is being taken precautions are taken to have the animal perfectly still. No anæsthetic was found necessary. The rat was conveniently secured on its back on a wooden board by string attachments tied to each of its four paws while the head is fixed by hooking up the incisor teeth. This simple method of fixing was quite efficient and no clamps were needed as suggested by Drury and Harris. For the rats the leads were inserted one under the right leg and the other, which corresponds to the second lead, under the left chest wall. The record is taken when the animal is still.

The diets.

The control pigeons were given mixed grains and the vitamin B_1 deficient pigeons washed polished raw rice. The control rats were given the laboratory stock diet consisting of wheat *chapatties* smeared with butter, fresh raw cabbage, raw carrots, sprouted Bengal gram and fresh milk (5·0 c.c. per rat) every day. Lean meat was given twice a week. The vitamin B_1 deficient diet was the same as that described by Harris (1934): sugar 60 parts, arachis oil 15, casein 20, salt mixture 5, autoclaved marmite 6, and cod-liver oil one drop per rat per day. The marmite was titrated with glass electrode and alkali to pH 10 and then autoclaved at 130°C. for one hour.

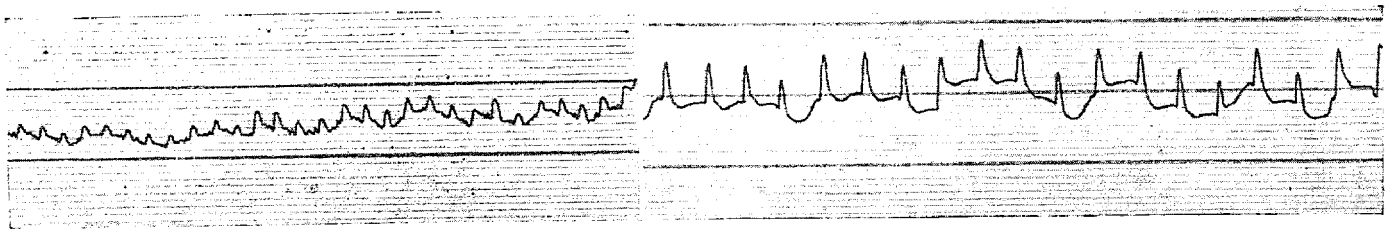
Results.

Pigeons.—Of the four pigeons in the deficient group three died within four weeks of being put on the experimental diet. All four developed 'polyneuritic' symptoms. Bradycardia was present in two deficient animals, the heart rate being from 185 to 285. The rate in four control pigeons fed mixed grains varied between 300 and 450. Large variations were observed in the heart rate of a group of four animals fed on washed polished raw rice with the addition of 20 mg. of the vitamin B_1 International Standard Preparation.

Rats.—Two groups, each consisting of 24 animals, were used for the experiment. Ten deficient animals developed paralysis of the hind limbs in about 6 to 7 weeks. All the group which survived longer than 2 weeks showed a progressive drop in the heart rate. The heart rate in the animals fed on the stock diet remained about 450 to 550 throughout a period of 7 weeks. In the deficient animals the rate dropped to about 225 to 270 in 4 to 7 weeks. One animal showed a rate as low as 75 and another 150. These two were moribund at the time of taking the record. Two of the animals died within two weeks. When the animals with a heart rate of about 250 were given foods containing vitamin B_1, such as sprouted gram or *chapatties*, they recovered their normal heart rate. It was observed that the heart rate did not drop in all cases when paralysis had set in. There were cases in which an animal showed paralysis and the heart rate did not drop, until a few days after the appearance of paralysis. In some animals which showed no paralytic symptoms a low heart rate and heart block were observed. The figures of heart rate are given in Tables I and II. A few representative cardiographs of animals—showing the normal cardiograph, bradycardia and heart block—are given in Fig. 1.

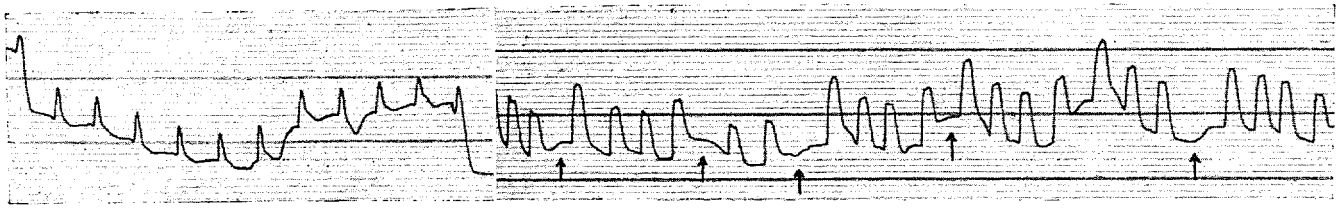
Vitamin C deficiency.

Guinea-pigs were used as the experimental animals. The scorbutic diet consisted of crushed oats and 50 c.c. of autoclaved milk per animal per day, and the control diet consisted of cabbage, carrots, sprouted Bengal gram, and rice bran. Twelve animals were put on each diet and cardiograph tracings of each animal secured every week for a period of 84 days. During this period only two animals in the vitamin C deficient group died, both within 35 days. To prevent the animals dying off rapidly, a little cabbage was given to every animal that appeared very sick.



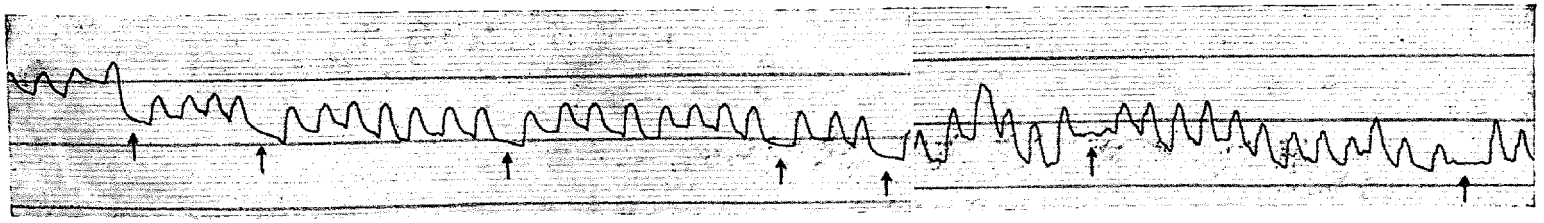
Rat No. 6252. Normal. Heart rate, 510.

Rat No. 6233. Bradycardia. Heart rate, 255.



Rat No. 6225. Bradycardia. Heart rate, 225.

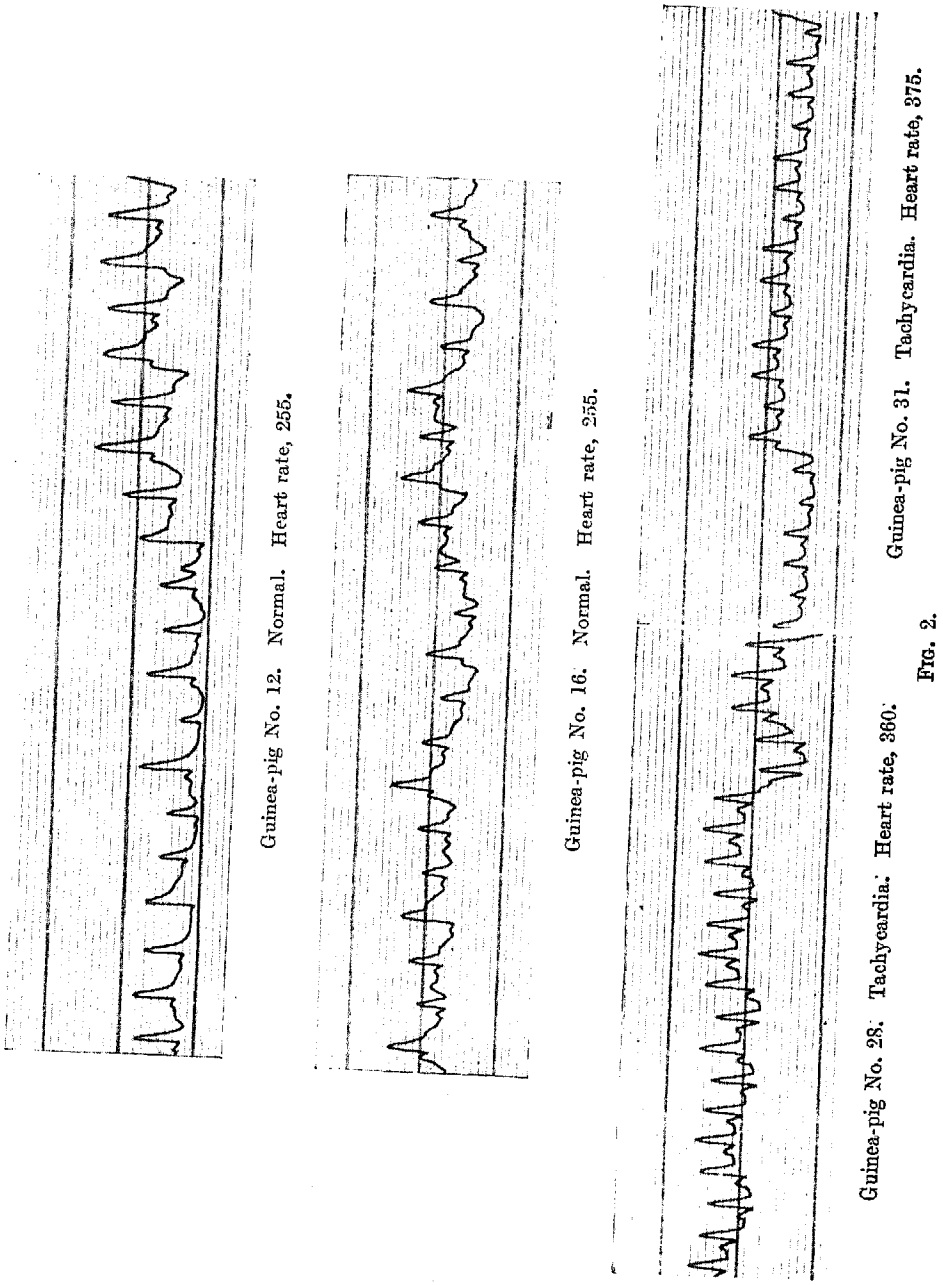
Rat No. 6219. Heart block. Heart rate, 270.



Rat No. 6231. Heart block. Heart rate, 285.

Rat No. 6225. Heart block. Heart rate, 300.

FIG. 1.



Guinea-pig No. 12. Normal. Heart rate, 255.

Guinea-pig No. 16. Normal. Heart rate, 255.

Guinea-pig No. 28. Tachycardia. Heart rate, 360.

Guinea-pig No. 31. Tachycardia. Heart rate, 375.

FIG. 2.

RESULTS.

The average heart rate of normal guinea-pigs was found to be between 250 and 275 per minute. Animals on a scorbutic diet showed a marked increase in the heart rate to as much as 300 to 375. The increase was found to begin after the ninth week. This result is in accord with the clinical observation that tachycardia occurs in human scurvy. Table III gives the data obtained. The cardiographs of a guinea-pig and of a scorbutic animal are appended in Fig. 2.

TABLE I.

Heart rate in rats.

STOCK DIET.

Experiment commenced on 10-8-34.

Rat number.	18-8-34	24-8-34	4-9-34	10-9-34	17-9-34	24-9-34	2-10-34
6239 ..	480	525	435	..	..	..	450
6240 ..	570	435	465	..	..	..	435
6241 ..	465	450	480	..	..	..	540
6242 ..	600	465	465	..	..	..	495
6243 ..	480	600	465	..	..	..	435
6244 ..	510	495	495	..	..	..	570
6245 ..	510	495	510	..	..	..	..
6246 ..	450	540	585	..	..	..	570
6247 ..	510	525	510	..	..	..	..
6248 ..	555	600	510	..	..	..	495
6249 ..	525	510	435	..	..	..	525
6250 ..	540	510	540	..	..	..	465
6251 ..	510	495	450	..	..	..	405
6252 ..	510	480	465	..	..	..	405
6253 ..	510	465	480	..	..	..	480
6254 ..	480	480	465	..	..	..	570
6255 ..	510	465	435	..	..	..	435
6256 ..	570	465	495	..	..	..	435
6257 ..	600	480	525	..	..	..	510
6258 ..	495	450	435	..	..	..	525
6259 ..	540	465	525	..	..	..	510
6260 ..	540	495	495	..	..	..	570
6261 ..	480	450	435	..	..	..	450
6262 ..	480	495	450	..	..	..	495

TABLE II.

Heart rate in rats.

VITAMIN B_1 DEFICIENT DIET.

Experiment commenced on 10–8–34.

Rat number.	18–8–34	24–8–34	4–9–34	10–9–34	17–9–34	24–9–34	2–10–34
6215 ..	615	570	540	525	525	315	210
6216 ..	555	540	75	..	..	..	..
6217 ..	570	555	450	300	..	..	..
6218 ..	540	510	420	420	345	270	..
6219 ..	540	510	435	330	270	270	270
6220 ..	435	540	450	360	345	300	240
6221 ..	450	480	450	390	390	285	255
6222 ..	540	480	450	480	430	300	270
6223 ..	540	570	510	374	465	210	465
6224 ..	525	525	450	450	450	210	525
6225 ..	510	420	300	390	225	..	..
6226 ..	570	510	555	405	375	300	255
6227 ..	585	510	495	435	435	315	285
6228 ..	570	480	420	420	150	..	..
6229 ..	540	510	480	465	420	270	..
6230 ..	600	540	510	465	285	..	..
6231 ..	555	480	285	390	Cured	..	..
6232 ..	585	450	480	405	390	330	285
6233 ..	540	405	420	255	450	Cured	..
6234 ..	510	525	510	435	345	315	255
6235 ..	525	510	450	420	435	345	300
6236 ..	555	525	480	435	345	285	222
6237 ..	540	..	..	..	..	..	..
6238 ..	540	..	..	..	..	..	..

TABLE III.

Heart rate in guinea-pigs on control and scorbutic diets.

Experiment commenced on 24–9–34.

CONTROL DIET.

Animal number.	22–10–34.	29–10–34.	5–11–34.	12–11–34.	19–11–34.	26–11–34.	3–12–34.	10–12–34.	17–12–34.
10	345	345	345	315	330	345	345	285	270
11	285	300	330	285	330	300	315	270	285
12	360	330	315	330	315	285	285	255	240
13	255	245	300	255	315	255	285	255	285
14	315	345	315	265	300	265	240	250	245
15	225	270	330	280	290	230	285	210	225
16	180	210	190	230	285	250	270	255	266
17	330	315	345	320	345	345	270	240	230
18	240	285	320	285	285	215	315	285	285
19	210	255	300	285	315	275	270	240	255
20	285	270	285	255	285	255	240	215	225
21	240	300	320	315	285	285	255	255	270
TOTALS ..	3,270	3,470	3,695	3,420	3,680	3,305	3,275	3,015	3,080
AVERAGES ..	273	289	308	285	307	275	273	251	257

TABLE III—*concld.*

SCORBUTIC DIET.

Animal number.	22–10–34.	29–10–34.	5–11–34.	12–11–34.	19–11–34.	26–11–34.	3–12–34.	10–12–34.	17–12–34.
22	300	300	285	255	270	270	315	330	335
23	285	270	315	290	330	305	315	330	335
24	180	240	240	240	250	240	285	305	300
25	345	300	..	..	..	..	..	..	..
26	240	255	240	240	255	225	285	330	330
27	330	330	300	270	300	300	335	345	375
28	225	375	345	270	300	315	360	360	360
29	345	360	350	330	330	290	335	345	345
30	270	315	270	315	285	240	285	315	315
31	330	345	300	305	305	315	345	360	375
32	285	..	..	..	..	..	..	..	..
33	375	335	315	360	330	270	300	330	330
TOTALS ..	3,510	3,455	2,960	2,875	2,955	2,770	3,160	3,350	3,400
AVERAGES ..	293	314	296	288	296	277	316	335	340

CONCLUSIONS.

(1) Bradycardia was observed in two pigeons on a diet of polished rice.

(2) Rats fed on a vitamin B_1 deficient diet consistently show a drop in the heart rate, which rapidly returns to normal when foods rich in vitamin B_1 are given. The results obtained confirm the work of Drury and Harris.

(3) Guinea-pigs on a vitamin C deficient diet develop tachycardia.

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