The Effect of Noradrenaline on Heat Production in the New-Born Pig

Although calorigenic effect of noradrenaline (NA) has been demonstrated in many new-born mammals[1–4], LE BLANC and MOUNT[5] failed to find it in the new-born pig.

On the other hand, CURTIS and ROGLER[6] have shown that NA (36 µg/kg i.v.) increases plasma free fatty acids (FFA) level even in piglets of less than 3 days old and concluded that NA must have a calorigenic effect in the new-born considered. They suspected that the dose of NA applied by LE-BLANC and MOUNT (600 µg/kg s.c.) had been so high that vasconstriction had suppressed FFA release and consequently the calorigenic effect of the amine could not be demonstrated. We tried, therefore, to find out whether the calorigenic effect of NA would appear in piglets injected with a dose much smaller than that used by LEBLANC and MOUNT.

Material and methods. Six piglets (Large White) were used, first at the age of 4–6 days and then at the age of 11–13 days. Respiratory exchange measurements were made with a diaferometer (Kipp and Zonen, Holland) and body (rectal) temperature with a thermocouple thermometer (Ellab, Copenhagen). The piglets taken individually from the sow (without fasting) were weighed and after measuring their rectal temperature placed in a respiration chamber at thermoneutrality. They were allowed to calm down and lie down, and measurements of respiratory exchange were made for 50 min. Then the piglets were removed from the chamber, their rectal temperature measured and they were injected s.c. with 200 µg/kg body weight NA ('levonor', Polfa). After placing the piglet again in the respiration chamber, 0.5 h equilibration time was allowed and then measurements were made for another 70 min.

Results. Representative readings of O_2 galvanometer deflections presented in the Figure show that before NA injection there were no significant differences between consecutive readings, thus a mean value for the initial period could be calculated. The same concerns all the measurements made in 4–6 day-old piglets following NA injection, and in 4 out of 6 piglets aged 11–13 days. In the remaining 2 older piglets the rate of the respiratory exchange following NA injection changed with time. Their thermogenic response to NA seemed to be much stronger than in the other piglets of similar age. This, however, was not easy to evaluate as after approximately 40 min the piglets became somewhat excited and active. Because of this in these 2 cases double calculation of heat production was made. In the first one, the readings which might have been affected by the animal's activity (broken line in the Figure) were excluded. In the second calculation all the readings were taken into account.

The results, summarised in the Table, show that in the piglets aged 4–6 days mean values of heat production, RQ, and rectal temperature before and after NA injection were practically equal. In the older piglets injection of the same dose of NA caused a considerable rise of heat production ($P < 0.01$). Rectal temperature measured at the end of the trial was on average 0.5 °C higher than before the injection of NA ($P < 0.01$) and RQ values decreased by approximately 0.07 ($P < 0.001$).

Discussion. The thermogenic effect of NA in new-born mammals is generally related to the presence of brown adipose tissue[1–4]. As the new-born pig has no brown fat, a lack of the calorigenic reaction to NA could be expected. Indeed LEBLANC and MOUNT[5] did not find any reaction to NA in the piglets aged 0.7 to 5 days. These authors believed that in the immediate postnatal period piglets rely

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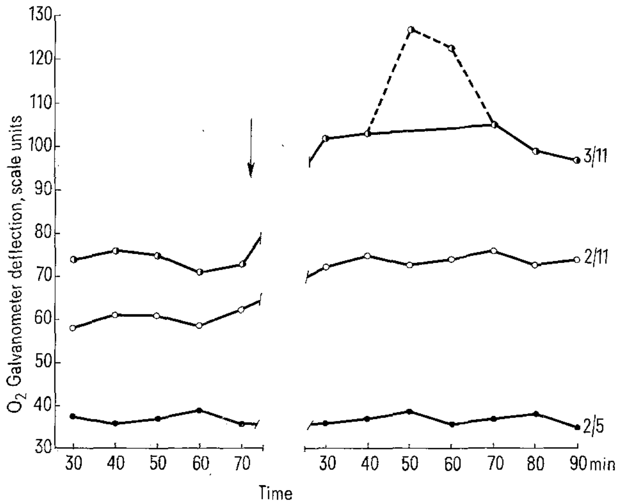
Rectal temperature, RQ and heat production before and after noradrenaline injection, 200 µg/kg sc, in piglets at 4–13 days of age

Piglet No.	Age, days	Body weight, g	Rectal temperature, °C Initial	After NA	Diff.	R. Q. Initial	After NA	Diff.	Heat production, kcal/kg/24 h Initial	After NA	Diff.
1	4	2050	39.5	39.6	+ 0.1	0.80	0.80	—	104.1	101.1	— 3.0
2	4	1770	40.0	39.8	— 0.2	0.77	0.76	— 0.01	128.0	123.7	— 4.0
3	5	1895	39.1	39.7	+ 0.6	0.80	0.79	— 0.01	98.5	100.8	+ 2.3
4	5	2060	40.0	39.8	— 0.2	0.87	0.76	— 0.11	126.4	119.6	— 6.8
5	6	1830	39.4	39.7	+ 0.3	0.80	0.80	—	105.8	116.9	+ 11.1[a]
6	6	2160	39.6	39.8	— 0.2	0.80	0.83	+ 0.03	105.9	106.7	+ 0.8
Mean		—	39.6	39.7	+ 0.1	0.81	0.79	— 0.02	111.4	111.5	— 0.1
P					> 0.5			> 0.5			> 0.5
1	11	4070	39.6	40.0	+ 0.4	0.84	0.76	— 0.08	101.1	119.4	+ 18.3
2	11	3830	39.8	40.2	+ 0.4	0.84	0.79	— 0.05	91.2	109.8	+ 18.6
3[b]	12	3640	39.9	40.8	+ 0.9	0.86	0.74	— 0.12	113.5	153.0	+ 39.5
3	12	3640	39.9	40.8	+ 0.9	0.86	0.80	— 0.06	113.5	169.8	+ 53.6
4	12	4030	39.9	39.9	+ 0.3	0.84	0.80	— 0.04	93.4	111.5	+ 18.1
5[b]	13	3340	39.6	40.3	+ 0.7	0.80	0.76	— 0.04	93.1	118.8	+ 25.7
5[c]	13	33.40	39.6	40.3	+ 0.7	0.80	0.76	— 0.04	93.1	133.2	+ 40.1
6	13	3900	39.8	40.2	+ 0.4	0.84	0.79	— 0.05	100.3	106.1	+ 5.8
Mean[b]			39.7	40.2	+ 0.5	0.84	0.77	— 0.07	98.8	119.8	+ 21.0
Mean[c]			39.7	40.2	+ 0.5	0.84	0.78	— 0.06	98.8	124.8	+ 26.0
P					< 0.01			< 0.001			< 0.01

Statistical significance assessed on the test of differences. [a] Heat production could be elevated by slight activity of the piglet after NA injection. [b] Readings probably affected by activity of the piglet eliminated in calculations. [c] All the readings taken into account.

mainly on carbohydrate metabolism for heat production and that the small thermogenic effect of NA found in the more than 1-week-old piglets may be due to the action of the amine on white fat, the contant of which increases markedly a few days after birth. However, MOUNT[7] later came to the conclusion that fat metabolism plays a considerably role in energy metabolism of piglets from the second day of life. Our results confirm MOUNT's conclusion, as RQ values found in the 4–6-day-old piglets ranged from 0.77 to 0.87. In spite of that no calorigenic effect of NA has been found in the piglets at this age. Therefore, one can conclude that although NA stimulates lipolisis in the piglets less than a week old[6], it does not stimulate fat oxidation. This conclusion is consistent with that of PERSSON et al.[8] who suggested that the newborn pig has a relative inability to increase oxidation of NA-mobilized FFA. In the older piglets, which react to NA by increasing their heat production, a small but highly significant decrease of the RQ was observed. The decrease attributed to NA action (as the time of fasting was the same as in the case of the younger piglets) would suggest that in piglets more than 10 days old the proportion of fat catabolized increases following NA administration.



O_2 consumption (expressed in units of galvanometer deflection) of piglets at different times after placing the animals in a respiration chamber. 2/5, piglet No. 2 at the age of 5 days, 2/11, the same piglet at the age of 11 days; 3/11, piglet No. 3 at the age of 11 days; an arrow, NA injection. Broken line connects the readings probably elevated by physical activity of the piglet.

Résumé. La production de chaleur, la température du corps et du QR de 6 porcelets âgés de 4 à 13 jours, avant et après l'injection s.c. de noradrénaline (200 µg/kg) ont été déterminées. On n'a pas constaté l'effet de l'injection de noradrénaline sur les animaux de 4–6 jours, pendant que le métabolisme et la température du rectum des porcelets âgés de 11–13 jours augmentaient distinctement, et que la valeur du QR a baissait significativement.

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An Inhibitory Effect of Prolactin on the Response of Rat Myometrium to Oxytocin

The hormonal control of uterine muscle is still not fully understood. At the end of human pregnancy, pituitary prolactin plasma levels are 10–20 times above non-pregnant levels and the hormone seems to be specifically concentrated in amniotic fluid[1]. Yet there appear to be no reports in the literature of any action of prolactin on the myometrium. This paper describes an inhibitory action of ovine prolactin on rat myometrium.

Ten virgin female hooded rats weighing about 140 g were studied. Five were treated for 3 days prior to experimentation with 0.25 µg stilbestrol per day given i.m. in oil. The other 5 were similarly treated with stilbestrol for 3 days with the addition of 2.5 mg progesterone on the 2nd and 3rd days. After killing an animal by a blow on the head, 2 parallel pieces of myometrium, 1.5 cm long and from the same uterine horn were prepared[2]. Each one was mounted in a bath in Krebs-Csapo solution[3] maintained at 37°C and bubbled continuously with 5% carbon dioxide in oxygen. Each piece was connected to a Devices isometric force transducer with a range of 100 g whose output was recorded on a moving paper chart. The transducers were mounted on micromanipulators allowing the lengths of the muscle strips to be accurately measured. After mounting the strips were left in the solution for 30 min in order to allow development of spontaneous rhythmic activity. Responses to oxytocin (Pitocin, Parke Davis) were tested by adding increasing concentrations to the baths. Maximal responses were achieved with concentrations ranging from 150 to 500 µU/ml. Once the maximal effect had been obtained the strips were washed 3 times with Krebs-Csapo solution and the following procedures followed: 1. The length of each strip was adjusted so that baseline tension was 1.5 g. 2. Oxytocin sufficient to cause an 80% of maximal effect was added to both baths: both strips contracted rhythmically and steadily. 3. Both strips were left for a 30 min control period. 4. Sheep pituitary prolactin (Ferring, Sweden, guaranteed free of other anterior and posterior pituitary hormones with the possible exception of growth hormone) was then added to one bath in a concentration of 10 µg/ml. The strip in the other bath acted as a control. 5. The experiment was continued for a further 12 h. At 3-hourly intervals both strips were washed and baseline tension readjusted until it was again 1.5 g. After each wash oxytocin was again added to both baths and prolactin to the test bath.

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