

Effect of Emotional Stress, Anesthesia, and Death on Body Temperature of Mice Exposed to Cold. (20247)

R. G. BARTLETT, JR., R. H. HELMENDACH, AND V. C. BOHR.
(Introduced by A. van Harreveld.)

*From the Department of Physiology, School of Medicine, College of Medical Evangelists,
Loma Linda, Calif.*

Hypothermia in small laboratory animals can be produced not only by exposure to cold(1) but can also be facilitated by wetting the body(2), lowering pO_2 (3,4), binding the thorax(5), restraining(6), a strange environment(7,8), and binding the hind limbs together(9).

Although some maintain that exposure to conditions less severe than intolerable cold produces a fall in body temperature if the animal is also stressed, restrained or fearful (6-10), others indicate that body temperature does not fall in a restrained or stressed animal unless breathing is restricted(5). The data presented below seem to support the former, *i.e.*, a theory of "emotional hypothermia."

Methods and materials. Adult Swiss albino mice of both sexes were divided into 4 experimental groups: 18 unrestrained, 18 restrained, 18 anesthetized, and 6 dead animals, respectively. Seventy mg/kg of sodium pentobarbital was used for anesthesia and an overdose of the same anesthesia was used to produce death. The unrestrained mice were maintained individually in large cages which were placed in a refrigerator ($6^\circ\text{C} \pm 2^\circ$) in which the restrained animals were simultaneously exposed in loose fitting cylindrical restraining cages. To minimize stress in the unrestrained animals, only initial and terminal (2 hr.) temperatures were taken, while in the other groups thermocouples inserted to a depth of 3-4 cm were left in the rectum and temperatures were taken intermittently throughout the exposure. Since others(5) have attributed the fall in body temperature, with similar restraining technics, to restricted breathing, another experiment was performed in which 48 mice were equally divided into controls and experimentals which were maintained for one hour each day in restraining cages at room temperature for a period of about 4 weeks. This "conditioning" was used

to determine if mice could become accustomed to restraining cages so that the caging would fail to produce an emotional stress. At the end of this period of conditioning both groups were exposed in restraining cages to the cold ($2^\circ\text{C} \pm 2^\circ$). One-half of these animals were exposed 3 days prior to the other half, the second group being used as controls on the first exposure. Initial and terminal (2 hr) temperatures were taken with a thermometer inserted rectally to a depth of 3 to 4 cm.

Results. The body temperatures of mice exposed in a refrigerator at a temperature of $6^\circ\text{C} \pm 2^\circ$ are shown in Fig. 1. While there was little drop in body temperature of the unrestrained mice, body temperatures of the animals in the restraining cages fell to the point of death in approximately one hour despite continuous struggling. The rate of the temperature drop is compared in Fig. 1 with the body temperature drop of anesthetized and dead mice recorded under similar conditions.

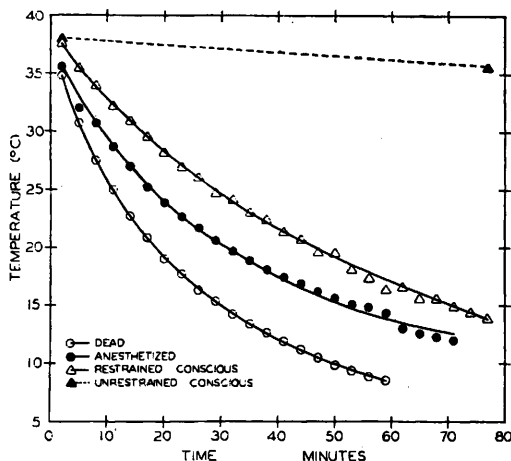


FIG. 1. Comparison of average temperature drop of dead mice, anesthetized mice, restrained conscious mice and unrestrained conscious mice in the cold ($6^\circ\text{C} \pm 2^\circ$).

TABLE I. Effect of "Conditioning" on Body Temperature Drop of Mice in the Cold ($2^{\circ}\text{C} \pm 2^{\circ}$).

Animal group	Initial temp., $^{\circ}\text{C}$	Terminal temp., $^{\circ}\text{C}$	% mortality
Controls— Not C* Not R*	38.3 ± 1.0	34.8 ± 1.6	0
R & not C	37.6 ± 1.2	13.0 ± 2.1	46
O & R	$38.2 \pm .9$	19.3 ± 3.3	0

* C = conditioned; R = restrained.

In Table I is shown the comparison of the temperature drop in the conditioned and non-conditioned animals in a cold room ($2^{\circ}\text{C} \pm 2^{\circ}$). As apparent from the figures, conditioning resulted in a lesser temperature drop in the animals in the restraining cages. Eleven of 24 of the non-conditioned animals died, while there was no mortality in the conditioned group.

Discussion. Although Ware, Hill, and Schultz(5) have reported that they were unable to produce hypothermia in rats without restricting breathing, there are several evidences of the existence of emotional hypothermia. Since in the present studies many of the mice were able to turn around in the restraining cages and in all cases a pencil could be moved between the back of the mouse and the cage, it was difficult to see how breathing could have been affected. Also, since the conditioned mice in our experiments were exposed to cold in an identical manner to the non-conditioned mice, it seems safe to conclude that the discrepancy of temperature drop between these two groups (Table I) cannot be attributed alone to the physical factors mentioned by Ware, but must also be attributed to emotional factors. It has also been observed in this laboratory that rats which live in restraining cages for a week or more do not lose body temperature on exposure to cold(10). The work of Phillips *et al.*(9) demonstrated that mice become hypothermic when the hind legs were bound together, a procedure which could not have restricted breathing appreciably.

It was also obvious that the body temperature drop did not result from restricted body

movements, for the caged animals struggled until the lowering of body temperature resulted in slower movement and finally in no movement as the temperature neared the death point. The controls, which were caged individually, were quite motionless and usually huddled up with ruffled fur.

In their work with rats, Ware *et al.*(9). found that with tight taping of the chest a drop in body temperature could be produced which was faster than the drop in dead animals. This relationship was not observed in the present studies, for temperature drop in both anesthetized and dead mice was faster than the temperature drop of caged conscious mice.

Summary. Both restrained and unrestrained mice were exposed to cold. The unrestrained animals experienced a small drop in body temperature as compared to the restrained animals whose body temperatures dropped to the death point (approx. 10°C) in about one hour. Anesthetized and dead mice demonstrated greater temperature drops than were found in conscious restrained mice. Conditioning by maintaining the animals one hour per day in restraining cages resulted in a lesser temperature drop on exposure to cold as well as greatly decreased mortality. It was concluded that emotional hypothermia, not resulting from restricted breathing, can be produced in mice by the stress of confinement.

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