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Return of Function of Sweat Glands After Cutting or Crushing Sympathetic Nerves.*

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Although considerable information is available concerning the regeneration of somatic nerves and the return of functions controlled by them, little is known concerning the regeneration of peripheral autonomic nerves.[1] The galvanic skin reflex and measurements of changes in cutaneous resistance and temperature when used as indices give information on whether regeneration is taking place but these methods do not give information quantitatively, on the extent of the return of peripheral autonomic activity which has taken place.[2]

In the present experiments measurements of the rate of sweating in the pads of the paws of cats have been made before and after the sympathetic nerves to them have been cut, to provide such data. The method is that of Neumann, Cohn and Burch,[3] adapted to the needs of these experiments. The hind paw is enclosed in an air-tight chamber through which is passed a continuous stream of dry oxygen. The dry gas takes up water lost by the paw and carries it into a tared metal coil immersed in a freezing mixture of alcohol and solid CO_2. The water suspended in the gas is deposited in the coil. After a suitable collection period (15 minutes) a new coil is substituted so that the collection of the water is continuous. The water-laden coil is dried and weighed. The difference in the weights before and after removal of water represents the water output for the period of collection. The method is accurate to 3%.

The water output from the pads of the normal right and left hind paws (area of paw approximately 30 sq cm, area of pad approximately 6 sq cm) was measured in 25 animals. When animals are at rest and the body temperature is normal (37 to 38.5°C) the water output reaches a basal level of 7 to 10 mg/15 min. This amount represents water lost by evaporation in the absence of active sweating from the pad. The same basal rate of water loss occurs from areas of skin devoid of sweat glands. The animals were then subjected to radiant heat in a cabinet, from which the paws were excluded, for a period of 45 minutes; the rectal temperature reached 40 to 41°C. The rate of water output increased 4 to 6 times (30 to 50 mg/15 min). The increase above the original or initial rate results from active sweating and is used as a quantitative measure of the activity of the autonomic fibers and will be referred to as the response. It is unnecessary in this connection to regard other functions for water loss in the bodies of cats.

Following unilateral denervation either by section and suture or by crushing of the sciatic and saphenous nerves the water output remained unchanged in the denervated leg and was without response to the influence of heating while the opposite normal leg responded as before. Eighteen animals were operated on, 10 by section and suture at the

* This is the 13th paper reporting the results of studies of the small blood vessels and related subjects.

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The Bureau of Medicine and Surgery does not necessarily undertake to endorse views or opinions which are expressed in this paper.

1 Young, J. Z., *Physiol. Rev.*, 1942, **22**, 318.

2 Richter, C. P., and Whelan, F., *J. Neurophysiol.*, 1943, **6**, 191.

3 Neumann, C., Cohn, A. E., and Burch, G. E., *Am. J. Physiol.*, 1941, **132**, 748.

level of the popliteal space; 8 by crushing.

Measurements of the loss of water were made periodically from the normal and denervated sides. In the series denervated by section and suture, 15 to 30 weeks elapsed before the first sign of response was observed. The amount of the response thereafter increased gradually. After an average of 41 weeks the rate of water output reached an average of 42% of that put out by the control side.

In the animals in which denervation had been accomplished by crushing, the return of the response was quicker and more complete. It commenced an average of 15 weeks after operation and in the nineteenth week had risen to 69% of that of the control side. In 4 of the 8 animals, complete return of function was attained; the others showed rapid increases in function with each succeeding week.

Comments. The amount of the return of the response of the sweat glands on heating the body of the cats measures, we believe, the amount of recovery of the sympathetic fibers. After the crushing operation, almost twice the function returned in less than half the time than when section and suture were employed. The possible role of atrophy of the sweat glands as a contributing factor in the result cannot be fully measured, but the complete return of function in 4 animals suggests that the glands retain their ability to respond as soon as innervation is restored.

Crushing the nerve does less permanent harm, obviously, than cutting it. This result resembles what has been found in somatic nerves and probably on the same basis—less interruption to the pathways over which regeneration takes place.[4] The present method of estimating the amount of return of function in peripheral sympathetic nerves may be useful in forecasting the rate and amount of recovery after injuries to peripheral nerves in human beings. The method may, of course, have value in deciding which procedures are best in facilitating the regeneration of injured nerves[5] and may have application in the clinical study of central nervous lesions and of drugs affecting the secretion of sweat.

[4] Gutmann, E., and Sanders, F. K., *J. Physiol.*, 1943, **101**, 489.

[5] Craig, W. M., *U. S. Naval Medical Bulletin*, 1943, **41**, 613.

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Utilization of Biotin and Biotin Methyl Ester by *Lactobacillus casei.*

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Kögl noted that biotin and its methyl ester are equally active for the growth of yeast (*Saccharomyces cerevisiae*, strain M).[1] Subsequently, it has been shown that biotin methyl ester can be utilized by a number of bacteria which require biotin for growth: *S. aureus*,[2] *B. radicicola*,[3] *Cl. butylicum*,[4] *Streptobacterium plantarum*[5] and a hemolytic streptococcus (C203S);[6] also by various

[1] Kögl, F., and Pons, L., *Z. physiol. Chem.*, 1941, **269**, 61.

[2] Kögl, F., and Van Wagtendonk, W. J., *Rec. trav. chem.*, 1938, **57**, 747.

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[4] Snell, E. E., and Williams, R. J., *J. Am. Chem. Soc.*, 1939, **61**, 3594.

[5] Möller, E. F., *Z. physiol. Chem.*, 1939, **260**, 246.

[6] Hottle, G. A., Lampen, J. O., and Pappenheimer, A. M., *J. Biol. Chem.*, 1941, **137**, 457.