action of protein and other agents against chloroform injury of the liver in dogs. The intracellular disturbances in the liver occasioned by chloroform and carbon tetrachloride intoxication respectively probably represent different phenomena. Evidence for this is the fact that a protective action was observed for both sodium thioglycollate and sodium glycollate against carbon tetrachloride injury in rats whereas in experiments in dogs with chloroform injury, sodium thioglycollate afforded protection but none was observed with sodium glycollate, indeed the liver appeared to be injured by this substance (unpublished experiments). Conversely, methionine afforded protection against chloroform injury in dogs but did not afford protection against carbon tetrachloride injury in rats.

Summary. Several agents were tested for protective action against carbon tetrachloride injury of the liver in rats. Marked protection was obtained with sodium thioglycollate, appreciable protection with glutathione, moderate protection with sodium thiomalate, and slight protection with cystein—all sulphydryl compounds. Sodium glycollate and sodium malate afforded protection comparable to their sulphydryl homologues. Methionine, and choline plus cystine did not afford protection. Other non-sulphydryl compounds, *i.e.*, sodium thiosulphate, aspartic acid, glutamic acid, choline, and sodium acetate afforded no protection.

A protective action against carbon tetrachloride injury of the liver in rats is not as closely related to the presence of –SH in the test agent as previously was observed for the protective action of certain compounds against hepatic injury by chloroform in the dog.

15203

Blood Pressure Changes During Electronarcosis.

A. VAN HARREVELD AND W. B. DANDLIKER.

From the William G. Kerckhoff Laboratories of the Biological Sciences, California Institute of Technology, Pasadena.

The blood pressure during the first phases of electronarcosis[1] shows large and complicated variations, mainly caused by the simultaneous stimulation of the sympathetic system and the vagus nerves.[1-5] The possibility that humoral mechanisms, other than those at the autonomic nerve endings, are active in producing these pressure changes, is here considered.

Method. Electronarcosis was produced by applying a 60-cycle alternating current to the brain through electrodes placed on both sides of the head directly behind the eyes. As usual, a relatively high current, in most cases 150 ma, was applied for the first 30 seconds, and then decreased to about 30 ma for the rest of the electronarcosis. Rabbits were used exclusively.

Recording mercury manometers were used for the registration of the blood pressure. Fastusol[6] was used to prevent blood clotting during the recording as well as in crossed circulation experiments.

The Blood Pressure Changes During Electronarcosis. On starting the high initial current, the blood pressure drops due to vagus inhibition, causing arrest of the heart. After

[1] Frostig, J. P., van Harreveld, A., Reznick, S., Tyler, D. B., and Wiersma, C. A. G., *Arch. Neurol. Psych.*, 1944, **51**, 232.

[2] Bikeles, G., and Zbyszewski, L., *Arch. f. d. ges. Physiol.*, 1920, **182**, 157.

[3] Ivy, A. C., and Barry, F. S., *Am. J. Physiol.*, 1932, **99**, 298.

[4] Roos, J., and Koopmans, S., *Vet. J.*, 1934, **90**, 232.

[5] van Harreveld, A., and Kok, D. J., *Arch. Néerl. de Physiol.*, 1934, **19**, 24.

[6] Modell, W., *Science*, 1939, **89**, 349.

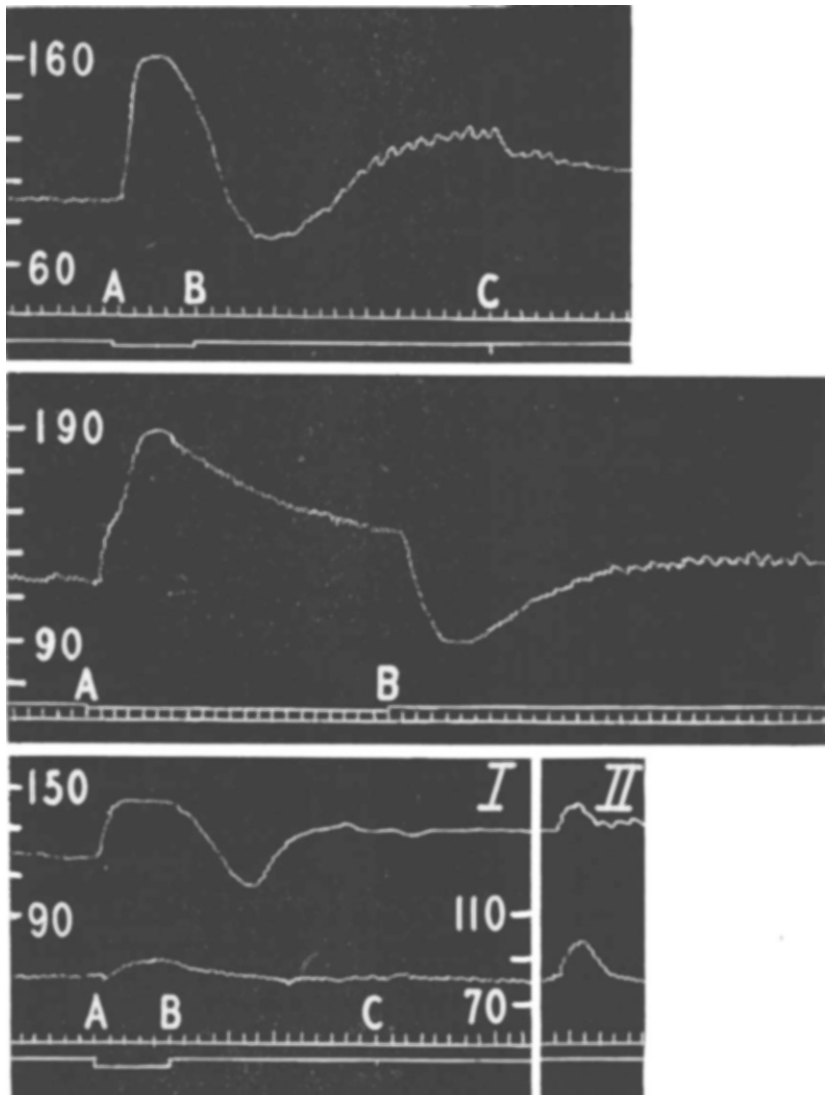

FIG. 1. Rabbit, 50 mg nembutal, 1 cc intocostrin, vagus nerves cut. At "A" a current of 150 ma is applied for 30 sec. This is decreased to 30 ma at "B" and the current is cut at "C." Time 6 sec. Blood pressure in mm mercury.

FIG. 2. Preparation of the animal as in Fig. 1. At "A" a current of 150 ma is applied, which is cut after 2 minutes at "B."

FIG. 3, I and II. Crossed circulation experiment, 50 mg nembutal was administered to both animals, the electronarcotised rabbit obtained 1 cc intocostrin (injected before the crossed circulation was established). Blood flow 110 cc/min. The upper blood pressure record is from the electronarcotised animal, the lower from the test rabbit. At "A" a current of 150 ma was applied, which was decreased to 30 ma at "B," and cut at "C." Fig. 3 II shows the effect of the injection of 10^{-5} gram adrenaline into the jugular vein of the rabbit which was electronarcotised before.

a few seconds, the heart escapes and the blood pressure rises considerably above the prenarcotic value because of the concomitant vasoconstriction induced by sympathetic stimulation.[1]

After severing both vagi the blood pressure begins to rise almost immediately after the current is started, usually reaching a maxi-

mum within the first 30 seconds of high initial current (Fig. 1). With vagi severed or intact the blood pressure drops, sometimes considerably below the prenarcotic value, after the current is decreased to the 30 ma maintenance level. In the further course of electronarcosis a second increase of blood pressure usually develops which reaches its maximum 2 to 3 minutes after the start. Neither the respiratory arrest (if not too prolonged) nor the strong convulsions present during the first phases of electronarcosis have a pronounced effect on the course of the blood pressure changes, since continuous artificial respiration applied to the completely curarised* animal does not alter materially these changes.

The sudden drop in blood pressure is clearly related to the change from high to maintenance current, since it is delayed when the initial high current is prolonged. If the high current is maintained for two minutes, for instance, the pressure, after reaching a maximum within the first 30 seconds, decreases slowly until the current is cut, when it drops quickly below the prenarcotic value (Fig. 2). (This experiment was performed in the curarised animal under artificial respiration, since the continued high current prevents the return of spontaneous respiration.)

Humoral Mechanisms in the Blood Pressure Changes During Electronarcosis. The release during electronarcosis of vasoactive substances has been studied in crossed circulation experiments. A symmetrical double carotid-jugular anastomosis was made between electronarcotised and test rabbits. The blood streams were so regulated that the blood pressure in each animal remained constant, indicating an equal flow in both streams. The flow into the test rabbit, which passed through a flow meter, was in most experiments of the order of 100 cc/minute, and was kept constant by a screw clamp regulator, despite blood pressure changes in the electronarcotised animal. In this way blood pressure changes in the test rabbit from mere changes in its blood volume were prevented. In both animals the vagus nerves were severed bilaterally.

Fig. 3 I is an example of such an experiment. About 8 seconds after the start of electronarcosis the blood pressure of the test animal starts to rise, reaching a maximum in about 30 seconds, after which the pressure slowly returns to its original level. The injection of 10^{-5} g adrenaline in the jugular vein of the animal previously subjected to electronarcosis, causes the blood pressure increases of Fig. 3 II.

The rise in pressure in the test rabbit is largest during the first current application; on repetition at intervals of 10 minutes it soon vanishes, though the pressure changes in the electronarcotised animal remain essentially alike.

Ellis and Wiersma[7] have shown that electronarcosis increases the release of tropic hormones of the pituitary gland. The blood pressure rise in the test rabbit might therefore be due to pitressin. This possibility was investigated by recording the blood pressure in animals in which the nervous connections of the head with the body were severed as completely as possible. A high spinal transection (C 5) was performed 2 days before the experiment, and vagus and phrenic nerves† were severed shortly before applying electronarcosis. In such animals the effect of electronarcosis on the blood pressure was minor, indicating that a hypophyseal effect, if present at all, is a negligible factor in the pressure rise.

The strong excitation of the sympathetic system during electronarcosis probably causes a release of adrenaline (and perhaps of sympathin) in the general circulation; and this substance may cause the blood pressure rise in the test animal in the crossed circulation experiments.

Conclusions. A comparison of the blood pressure rises in the electronarcotised and test animals during electronarcosis and after the injection of 10^{-5} g adrenaline (Fig. 3 I and II) shows that the rise during electronarcosis

* Intocostrin (E. R. Squibb and Sons, New York) was used.

[7] Ellis, C. H., and Wiersma, C. A. G., PROC. SOC. EXP. BIOL. AND MED., 1945, **58**, 160.

† The circulation in the high spinal rabbit is so precarious that respiratory arrest often caused a considerable drop in blood pressure, probably by impairing the venous return to the heart. Artificial respiration, after severing the phrenic nerves, was therefore used.

(after elimination of the vagus effect) can be explained only for a small part by hormonal mechanisms. It must be mainly a nervous phenomenon.

The considerable drop in pressure, which occurs when the high initial current is reduced, may be due to a period of decreased responsiveness of the sympathetic system after the strong stimulation. Normal stimuli and those set up by the lower maintenance current would then be unable to maintain the high or even the normal blood pressure. This is supported by the observation that, when electronarcosis is repeated at intervals of 10 minutes, this drop tends to become more marked.

The second maximum in blood pressure (Fig. 1) may be caused by impulses produced in the sympathetic by the smaller maintenance current, after this system has recovered from the effects of the high initial current.

15204 P

Fungistatic Action of Hair Fat on *Microsporon audouini*.*

STEPHEN ROTHMAN, ADELAIDE M. SMILJANIC, AND ARTHUR L. SHAPIRO.

From the Section of Dermatology, Department of Medicine, University of Chicago, Chicago, Ill.

In the last few years ringworm of the scalp caused by *Microsporon audouini* has been endemic among school children in the major cities of the United States. This infection disappears spontaneously with oncoming adolescence, and the scalp hair of adults is completely immune to the invasion of the fungus. The non-hairy skin remains susceptible in adults.[1] It has been obvious that the change in susceptibility during adolescence is due to the sudden development of sebaceous glands of the scalp under the influence of sex hormones, and to the associated changes in the chemical composition of the sebum. In this laboratory it was attempted to trace these changes in order to find the explanation for the immunity of adults' hair.

Experimental. Hair of adults was pooled from barber shops and extracted with hot ether. The hair fat was added to Sabouraud's agar medium in graded concentrations. The agar tubes were then inoculated with a standard culture of *M. audouini*. It was found that hair fat had an inhibitory action on the growth of the fungus, and that the minimum concentration preventing growth was 0.5%. Examining the hair of medical students who did not use any hair tonic or pomade in a one-week period between washing and cutting the hair, we ascertained that the fungistatic effect was not caused by extraneous material. Fat from children's pooled hair had ⅓ the fungistatic action of adults' hair fat.

Adults' hair fat was fractionated and the activity of the fractions was assayed on *M. audouini* cultures (Table I). By treating the fat with cold 1% NaOH the free fatty acid fraction was split off. This fraction contained the whole fungistatic principle whereas the remainder, containing neutral fats, cholesterol, and other unsaponifiable material, was inactive. Subsequently, steam distillation of the free fatty acid fraction was carried out, and the active principle was recovered from the steam distillate. The final step was fractionation of the steam distillate. The first fraction distilling over between 90 and 105°C at 1 to 2 mm Hg pressure contained most of the fungistatic material.

This active fraction was isolated in 2 separate experiments. In both cases 12 kg of hair was used. The yield of active fraction was 20.3 mg and 35.5 mg respectively. A second fraction (55.5 mg) distilling around 110°C was isolated once and had similar fungistatic power to the lower boiling fraction. Microanalysis of these samples (Table II)† indi-

* Aided by a grant from Wallace & Tiernan Products, Inc., Belleville, N.J.

1 Rothman, S., *Hygeia*, 1945, **23**, 436.

† Microanalyses were performed by Dr. T. S. Ma, Department of Chemistry.