TABLE II.
Duration of Infection
As determined by recovery of viable gonococci from eyes at various times after inoculation.

Time after inoculation	No. of eyes cultured	No. of eyes positive	% positive
1 day	10	10	100
2 days	11	10	91
3 "	12	9	75
4 "	12	7	58
5 "	15	7	46
6 "	24	11	45
7 "	23	8	35
2 wks	6	2	
3 "	4	2	
4 "	4	1	
5 "	4	1	
6 "	4	2	
7 "	2	1	
8 "	6	3	
9 "	4	2	
10 "	10	3	
11 "	6	2	
12 "	2	0	
14 "	2	2	

at various times during life and found to contain living gonococci.

Discussion. The lesion produced in the anterior chamber of the rabbit's eye by the introduction of gonococci is regarded as a genuine infection for the following reasons: Viable gonococci were recovered from 93% of the inoculated eyes at the end of 24 hours and from 39% at the end of 7 days. The inoculated gonococci were found to invade the neighboring tissues (lens and ciliary body) and definite evidence of multiplication was obtained. The infection could be transmitted in series by transfer of a drop or two of aqueous humor, but this method of animal passage was impracticable for routine experimental purposes, because contaminants could not be detected until after the transfer had been made. In approximately ⅓ of the inoculated animals the infection became chronic and persisted until the end of the longest period of observation which was 14 weeks.

This infection has been found to lend itself to the study of local and systemic therapy of gonococcal infection and to the testing of gonococcidal agents *in vivo*.

Summary. A method is described for the production of a localized gonococcal infection in the rabbit's eye by inoculating gonococci into the anterior chamber. Gonococci were found to invade the tissues of the eye, to multiply there and to produce severe inflammatory reaction. In approximately ⅓ of the animals the infection became chronic and viable gonococci persisted as long as 14 weeks, the maximum period of observation.

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14876

Influence of Muscle Pain on Electrical Resistance of the Human Skin.*

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It was shown in a series of investigations from this laboratory[1-4] that muscle pain greatly influences the somatic nervous system at spinal and supra-spinal levels. Autonomic changes occur also under these conditions as evidenced by pupillary dilatation which is based on an inhibition of the tone of the third

* Aided by a grant from the National Foundation for Infantile Paralysis, Inc.

1 Gellhorn, E., and Thompson, L., *Am. J. Physiol.*, 1944, **142**, 231.

2 Gellhorn, E., and Thompson, L., PROC. SOC. EXP. BIOL. AND MED., 1944, **56**, 209.

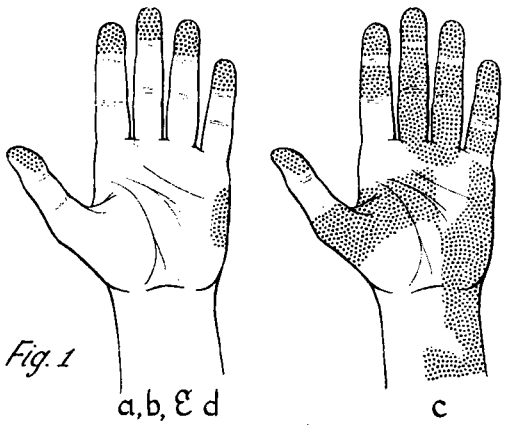
3 Gellhorn, E., *Journal Lancet*, 1944, **64**, 242.

4 Thompson, L., and Gellhorn, E., PROC. SOC. EXP. BIOL. AND MED., 1945, in press.

nerve nucleus.[5] Although the sympathetic innervation of the pupil remained unchanged it seemed likely that other structures might reveal signs of altered sympathetic innervation under the influence of muscle pain. The experiments reported in this paper give positive evidence for this assumption.

Method. Sixteen normal adults served as subjects in this series. The skin resistance of the left hand and in some experiments of face and foot was determined by the method of Richter[6,7] and the area of low resistance was mapped out. Thereafter the right forearm and hand or the right lower leg were made ischemic by means of a blood pressure cuff applied above the elbow or knee and inflated to a pressure of 200 mm Hg. In other experiments a tourniquet was applied to the shoulder. After the effect of ischemia on the low resistance area had been determined ischemic pain was induced by repeated movements of the ischemic muscles (Lewis[8]) or, in a few instances, by immersion of the ischemic hand and forearm in water of 115°F (Harpuder and Stein[9]). As soon as pain became manifest the area of low skin resistance was again determined. As was pointed out in previous papers the pain disappeared almost immediately upon restoration of circulation. A second control experiment was performed about 10 minutes after cuff or tourniquet had been removed.

Results. The results are best described by reproducing the actual records of a typical case. Fig. 1 shows that the low resistance area is restricted on the volar surface of the hand to the tips of the fingers and thumb, and to a small part of the hypothenar eminence. Ischemia does not alter the boundaries of the low resistance area, but under the influence of ischemic pain originating in the right biceps the low resistance area covers the greater part



Effect of ischemic pain in the right biceps on the skin resistance of the left hand: (a) control; (b) ischemia of the right arm, shows this same area of low resistance; (c) ischemic pain of right biceps, shows extension of low resistance area; (d) control, 10 minutes after restoration of circulation, shows the same low resistance area as in a.

of the volar surface of hand and fingers. A control experiment performed about 10 minutes later shows that the effect is completely reversible.

Such experiments were carried out on several persons 2 to 4 times with very similar results. The area of low resistance was very constant in spite of the fact that, in some instances, several weeks had passed between the individual experiments. The effect of pain showed only slight quantitative variations in the extent of the low resistance area.

Fig. 2 shows the effect of ischemic pain induced in the right foot on the skin resistance of the left hand on the same subject. Under these conditions the area of low resistance is extended to the greater part of the volar surface of hand and fingers and to the flexor surface of the forearm up to a line about 10 cm above the wrist.

Experiments on other subjects confirm these results, showing that the volar surface of the fingers, palm, and forearm are the areas which are involved in decreasing degree in conditions of muscle pain.

These effects are likewise observed if the ischemic fingers or hand and forearm are immersed in water of 115°F. Harpuder and Stein state that pain is largely of cutaneous origin if the fingers alone are immersed but that cutaneous and muscle pain are evoked

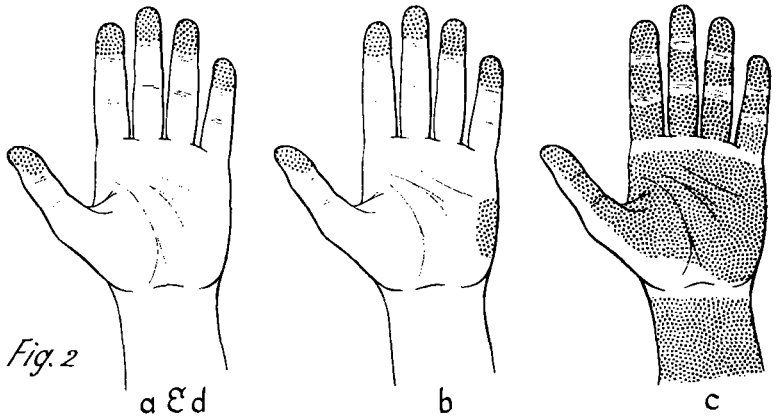
[5] Ury, B., and Gellhorn, E., *J. Neurophysiol.*, 1939, **2**, 268.

[6] Richter, C. P., and Woodruff, B. G., *Bull. Johns Hopkins Hosp.*, 1942, **70**, 442.

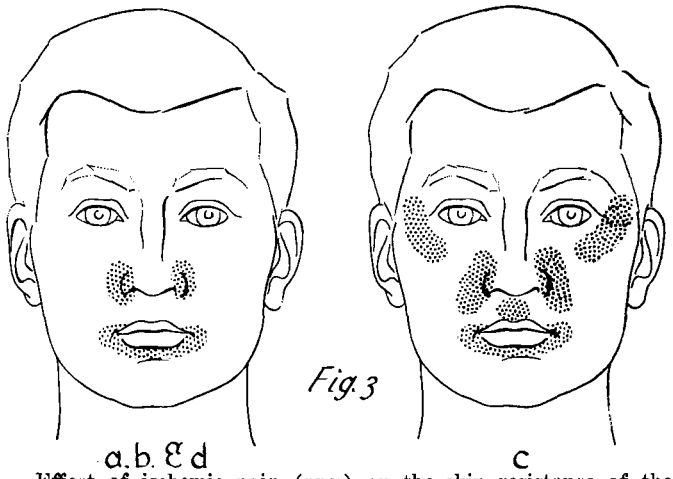
[7] Richter, C. P., Woodruff, B. G., and Eaton, B. C., *J. Neurophysiol.*, 1943, **6**, 417.

[8] Lewis, T., *Pain*, N.Y., 1942.

[9] Harpuder, K., and Stein, I. D., *Am. Heart J.*, 1943, **25**, 429.



The effect of ischemic pain in the right foot on the skin resistance of the left hand: (a) control; (b) ischemia, shows the same distribution of low resistance area except for a small area appearing on the hypothenar; (c) ischemic pain of right foot, shows increase in low resistance area of left hand; (d) control, 10 minutes after restoration of circulation, shows that low resistance area is the same as in (a).



Effect of ischemic pain (arm) on the skin resistance of the face: (a) control; (b) ischemia of right arm, the low resistance area remains unchanged; (c) ischemic pain of right arm, low resistance area of face increases slightly: (d) control, 10 minutes after restoration of circulation, low resistance area as in (a) and (b).

if hand and forearm are immersed at the same time. Other skin areas may likewise be involved, but to a much smaller degree than the volar surface of the hand. Thus, in some instances it was found that an area of low resistance appeared on the dorsum of the hand, and in another subject, the low resistance area extended on the flexor side up to the shoulder. On the dorsal and plantar surface of the foot appeared after pain small areas of low resistance which were absent under control conditions and during the period of ischemia. Changes in the resistance of the skin of the face were slight in spite of the fact that vasomotor effects (flushing) were quite common as a result of pain. The effect consisted in a slight enlargement of the area of low resistance observed under control conditions and in the appearance of additional areas formerly showing relatively high resistance (Fig. 3).

Discussion. According to the investigations

of Richter and collaborators the area of low resistance in the skin is related to sympathetic innervation and to the distribution of sweat glands. These areas expand in conditions associated with increased sympathetic activity such as muscular exercise and emotional excitement, and decrease in sleep. Cold and warm tub baths respectively decrease and increase the size of the low resistance area. In the light of these observations the reversible enlargement of the areas of low resistance under the influence of muscle pain indicates that the latter increases sympathetic discharges. This effect is likewise observable under conditions of cutaneous pain. There is, however, another interpretation possible which could point to the relationship between these effects of pain and emotion and attribute to the emotional disturbances induced by pain the changes described in this paper. This objection is held invalid for two reasons: first, the persons on whose experimental records this investigation is based were selected from a larger group because of their emotional stability and low sympathetic excitability as indicated by the size of the low resistance area of the skin. Richter mentions that the low resistance area comprises the whole volar surface of the skin. We find this to be true only for rather excitable persons who were excluded from this series for this reason. Secondly, the experiments were performed repeatedly on the same subjects with very similar results although emotional disturbances would be apt to decline on repetition.

Richter points out that the distribution of the low resistance area in the skin does not reflect either the distribution of peripheral nerves or that of spinal dermatomes, but rather that of cortical patterns of autonomic innervation. This statement seems to be valid for the changes seen as a result of muscle or cutaneous pain. It is of interest to mention in this connection an earlier investigation which demonstrated an increased responsiveness of the motor cortex to electrical stimulation as a result of muscle pain.[1]

Summary. Muscle or cutaneous pain induced by movements of muscles in ischemia or immersion of ischemic fingers in hot water increases the area of low resistance of hand, forearm, and face reversibly. The effects indicate increased sympathetic discharges. The pattern suggests the involvement of supraspinal mechanisms.

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Increased Germicidal Efficiency of Iodine in the Presence of an Oxidation-Reduction System.

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In a previous communication[1] it was shown that inorganic salts of iron, manganese, and tin, when tested individually, exhibited very little or no germicidal activity against the test organism *Staphylococcus aureus*. However, if an oxidized and a reduced salt, such as ferric and ferrous sulfates, were dissolved in water to form an oxidation-reduction system, the solution exhibited a pronounced germicidal action. The phenomenon was shown to be a function of the positive metallic ions; the negative ions apparently played no part in the reaction. For example, a mixture of sodium sulfate and sodium sulfite exhibited no increase in germicidal activity over that of the same salts tested individually.

The salts must be combined in certain definite proportions for maximum germicidal activity to occur. In the case of the chlorides of iron, the most effective germicidal activity occurred when the salts were mixed in the proportion of two moles of ferric chloride and one

[1] Guest, Howard L., and Salle, A. J., PROC. SOC. EXP. BIOL. AND MED., 1942, **51**, 272.