Experiment 8.—Rabbit, 700 grams, in full digestion. Chloral-ized lightly.

7 c.cm. KCN solution (0.1 per cent.) given.

4 minutes after giving KCN, 6 c.cm. adrenalin (1 in 10,000 given).

9 minutes after giving KCN, stomach washed out.

19 minutes after giving KCN, 3 c.cm. adrenalin (1 in 10,000 given).

Recovery.

Experiment 9.—Rabbit, 950 grams, 9.5 c.cm. KCN solution (0.1 per cent.) given:

5 minutes after giving KCN, 6 c.cm. adrenalin (1 in 10,000 given).

8½ minutes after giving KCN, Martin's antidote administered.

Convulsions. Recovery.

Experiment 10.—Rabbit, 1,250 grams. 12.5 c.cm. KCN solution (0.1 per cent.):

4 minutes after giving KCN, 3 c.cm. hemisine (1 in 10,000).

8 minutes after giving KCN, convulsions.

12 minutes after giving KCN, Martin and O'Brien's antidote given.

25 minutes after giving KCN, respirations ceased.

Experiment 11.—Rabbit, 1,300 grams. 13 c.cm. KCN solution (0.1 per cent.) administered:

3½ minutes after giving KCN, 3 c.cm. adrenalin (1 in 10,000) given; convulsions.

11 minutes after giving KCN, Martin's antidote + 2 c.cm. adrenalin (1 in 10,000) given; respirations were slowed.

15 minutes after giving KCN, respirations were of expiratory type for about one minute.

Conjunctival reflex absent and pupils dilated till about twenty-two minutes after poisoning. Pupils then began to contract somewhat. At this time the breathing was alternately mouth and nasal, and respirations were sixteen per minute. About thirty-seven minutes after poisoning respirations were twenty per minute, and breathing still mouth and nasal alternately. Conjunctival reflex returning fifty-two minutes after poisoning; respirations twenty-four per minute, and nasal in character. Animal apparently asleep, and breathing quietly, when it was left tied up in the laboratory two hours after administering the cyanide. Found dead next morning. There was a strong smell of gas in the laboratory and it is quite possible that the animal died of CO poisoning.

This experiment shows the beneficial effect to be derived from giving the animal a further small dose of adrenalin.

Experiment 12.—Rabbit, 1,300 grams. 23 c.cm. adrenalin (1 in 10,000) given. Twenty-four hours afterwards stomach examined. No pathological condition of mucosa apparent.

Experiment 13.—Rabbit. 35 c.cm. adrenalin solution (1 in 10,000) administered. Twenty-four hours afterwards no abnormal appearances in stomach, intestines, kidneys, liver, heart.

Experiments with Strychnine, Aconite, and Other Poisons.

Experiment 14.—Two rabbits, in full digestion, were taken.

Rabbit A, weight 950 grams. Received 11.5 c.cm. strychn. sulph. solution (that is, 12 c.cm. per kilogram body weight) into its stomach. Death occurred forty-two minutes after.

Rabbit B, weight 1,150 grams. Received 13.8 c.cm. strychn. sulph. solution + 4 c.cm. adrenalin (1 in 10,000) into its stomach. It was still alive four hours twenty minutes after, but was found dead next morning in position of opisthotonos.

Exner² showed that rabbits which received a dose of 0.0052 gram strychnine sulphate on the average exhibited convulsions in ten minutes and death in twenty minutes.

Experiment 15.—Dog, weight about 8½ kg.; starving; was morphined, and received ½ grain (0.025 gram) strychn. sulph., dissolved in 30 c.cm. saline.

10 minutes after giving the strychnine, 12 c.cm. adrenalin (1 in 10,000) were given.

16 minutes after giving the strychnine, stomach washed out.

21 minutes after giving the strychnine, 8 c.cm. adrenalin (1 in 10,000), immediately followed by 1 oz. mag. sulph.

Recovery.

A dog of about the same weight, size, age, and breed received ½ grain strychn. sulph., and died in six hours.

Experiment 16.—Eighteen days after Experiment 15. The same dog used; in full digestion; morphined. Received ½ grain (0.026 gram) strychn. sulph., dissolved in 30 c.cm. water.

12 minutes after giving the strychnine, 12 c.cm. adrenalin (1 in 10,000) given.

18 minutes after giving the strychnine, commenced washing stomach out.

27 minutes after giving the strychnine, 8 c.cm. adrenalin (1 in 10,000), immediately followed by 1 oz. mag. sulph.

Recovery.

Experiment 17.—Two rabbits in full digestion taken.

Rabbit A, weight 1,150 grams. Received 11.5 c.cm. lin. A.B.C. Died fifty-nine minutes after.

Rabbit B, weight 1,250 grams. Received 12.5 c.cm. lin. A.B.C. + 5 c.cm. adrenalin (1 in 10,000). Died two hours four minutes after.

Experiment 18.—Two rabbits in full digestion taken.

Rabbit A, weight 1,350 grams. Received 13.5 c.cm. lin. aconit. (lin. aconit. B.P., diluted ½). Died fifty-seven minutes later.

Rabbit B, weight 1,350 grams. Received 13.5 c.cm. lin. aconit. (lin. aconit. B.P., diluted ½) + 5 c.cm. adrenalin (1 in 10,000). Died six hours twenty-five minutes later.

Experiment 19.—Two rabbits in full digestion.

Rabbit A, weight 1,300 grams. Received 2 grams pot. oxalate in 20 c.cm. water. Died fifty minutes after poison.

Rabbit B, weight 1,400 grams. Received 2 grams pot. oxalate in 20 c.cm. water + 5 c.cm. adrenalin solution (1 in 10,000). Died fifty-eight minutes after poison.

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THE LATE VASOMOTOR PARESIS DUE TO ADRENALIN.

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A GENTLEMAN consulted me on account of multiple exostoses of the external auditory meatus, which so far occluded the lumen that beyond them only the finest Eustachian bougie was passable, and nothing was visible. Presumably the marked tinnitus, which was his chief complaint, was due to an accumulation of sebum and epithelial débris deep to the growths; for this tinnitus remained absent so long as he regularly used drops of hydrogen peroxide.

His unwillingness to persist with this treatment; a moderate degree of obstructive deafness to speech, acoumeter, and tuning-fork; and the danger that an infection of débris between the growths and the membrane might lead to perforation and otitis media, were the indications for surgical interference.

The external meatus was unusually tortuous; the growths, only one of which was pedunculated, were very deep, and at subsequent operation proved to be actually continuous with the annulus tympanicus. The difficulty of access emphasized the necessity for a clear bloodless field in operating. Therefore, before making the post-aural incision, adrenalin chloride was injected along the growths—5 drops of a 1 in 2,000 solution in each situation. The whole area became and remained remarkably bloodless, and a branch of the posterior auricular was the only vessel tied during the operation, at the conclusion of which a rubber tube, of such a length that its outer end hitched just under the tragus, was pushed down to the intact drum.

At the first dressing, on the third day, the tube had become slightly unhitched from the tragus, and had slipped out about 1 in. It could be pushed back, but on the release of pressure again emerged for this small distance, very slowly, as if levered up by an elastic body beneath. Next day the tube projected about ½ in.; it was again replaced, and pressure applied over it by a small pad under the dressings.

On the fifth day, finding it impossible to keep the tube in position, it was removed, and an inspection made. The membrane was completely hidden by the edge of the skin of the posterior meatal wall, where this skin had been out across just distal to the growths; The skin could not be replaced in position, being pushed forwards from behind, presumably by blood-clot.

On the seventh day, as the flap showed no promise of retracting, I reopened the post-aural wound, and found that from here all along the posterior meatal wall bone and skin were separated by a clot. In amount this clot was sufficient to fill a dessert-spoon, and more than the space would be expected to hold; much of it lay in the deepest part of the meatus, levering the cut skin-edge forwards, so that it lay directly over and parallel to the drum. After the removal of the clot and the passage of a tube as before, healing, with a good lumen and cure of all symptoms, was uneventful.

This case shows that, apart from any of its general physiological disadvantages, adrenalin may cause mechanical trouble by reason of the vasomotor paresis which follows the phase of vaso-constriction.

THE BREAKING OF THE VICIOUS CIRCLE.

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DISEASE, when complicated by the presence of a vicious circle, presents problems for solution peculiar to itself. The physician is no longer confronted with a morbid process which Nature is doing her best to rectify, and where treatment mainly consists in furthering and regulating her efforts. When a circle is present Nature is aggravating the disorder. The *vis medicatrix* has become the *vis devastatrix*, and what looms before the sufferer is at best a prolonged disorder, at worst a *descensus Averni*.

Vicious circles are widespread in their distribution, and play a great part in clinical medicine. Their study promotes a visualization of those pathological sequences that are ever acting reciprocally on each other, and greatly assists the accurate adaptation of remedies to the complex conditions of disease.

Although a large part of the *ars medendi* consists in "breaking the circle," this aspect of therapeutics has, strange to say, almost wholly escaped attention. True, many years ago a great teacher wrote: "Let it be a cardinal principle of treatment to make an effort to interrupt vicious circles."¹ But even to-day our textbooks give but little assistance in the solution of problems presented by reciprocally acting consequences. It may be useful to indicate the principles on which treatment under such circumstances must be based, and to illustrate those principles by a few examples.

LOCUS MINORIS RESISTENTIAE.

One signal advantage presented by the circle is that there are at least two points at which its evil round may be interrupted. In the words of Lauder Brunton, "We must see where the circle can best be broken," since, "if we can break the circle at one point, we allow recovery to commence."² Our first step then is to seek the *locum minoris resistentiae*. The discovery may not be easy, inasmuch as it presupposes an accurate diagnosis of the various factors that constitute the circle, and this may involve a painstaking investigation, as emphasized by Clifford Allbutt:

First of all we shall begin by a close searching for any vicious circle of function, and, if found, of cutting any link of it, whatsoever or wheresoever. . . . A floating kidney, a disorder of the uterus, a faulty eye, a "tea" or "tobacco" heart, or other local irregularity, trivial enough perhaps in itself, may close and perpetuate the vicious orbit of function.³

When the factors constituting the circle have been elucidated, our duty is to break it through at the weakest point. If the gyration can be stopped the whirling currents will be restored to their normal direction. "The hound which had turned to hunting its own tail may be put again on the track."

The *modus operandi* will vary with the special circumstances of each case. But some illustrations may be grouped under the following heads:

- I. The breaking of the circle by hygienic measures.
- II. The breaking of the circle by surgical appliances.
- III. The breaking of the circle by drugs.
- IV. The breaking of the circle by operation.

I. The Breaking of the Circle by Hygienic Measures.

Rest.—Physical rest is a powerful means of breaking some circles. An illustration is presented by many cases of cardiac failure, where a dilated and overburdened myocardium is associated with visceral disorder, the two conditions acting and reacting on each other.

Gibson thus describes the circle:

Sooner or later, according to its form and severity, chronic valvular disease, with compensation, itself disposes to failure by establishing a vicious circle of slow, progressive impairment of the viscera and their great vital functions—the lungs, liver, stomach, bowels, kidneys, indeed the myocardium itself.⁴

In many such cases, if the patient is kept so quiet as "not to take one beat out of the heart more than can possibly be avoided," immense relief is given to the failing myocardium. More blood is sent to the lungs and viscera, and returns as a more nutrient and aerated supply. The cardiac action is strengthened, its tonicity is raised, so that the heart can pump out the stagnating blood and lower the venous pressure. Even moribund persons

THE BREAKING OF THE CIRCLE BY HYGIENIC MEASURES.

recover, and continue practically well for years. Lauder Brunton describes the value of such absolute rest:

As in many other things the conditions in cardiac disease form a vicious circle. The disordered circulation disturbs the function of other organs, and these in turn make the circulation worse. . . . In such cases it is evident that the patient is bound to die, and to die a somewhat painful death, unless medical art can afford him some assistance. It is very fortunate, however, that in such cases medical art can do so much. . . . If we break the vicious circle at one point, we allow recovery to commence; and one of the most important agents—I think I ought to say the most important agent—in the physician's power is absolute rest.⁵

Exercise.—Under other circumstances the opposite measures, namely, increased exercise, is called for, as in the circle of obesity, which Krehl describes:

As soon as the accumulation of fat begins to deter the patient from taking active exercise a vicious circle is established, and he tends to increase in weight more and more.⁶

If the physician insists on some athletic sport, or at any rate on a more active mode of life, the morbid correlations may be interrupted and health restored.

Cleanliness.—Want of cleanliness may give rise to various circles, as, for example, to seborrhoea genitalium, where retained and putrefying secretions irritate the prepuce and glans, and thus provoke further secretion and putrefaction. In Corner's words:

The greater the irritation of the glands by decomposing secretion the greater the amount of secretion they produce. In this way a vicious circle is established.⁷

The regular removal of these secretions will rapidly diminish the excessive glandular activity, and thus check the morbid reactions.