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PAIN

IN ITS

NEURO-PATHOLOGICAL, DIAGNOSTIC, MEDICO-LEGAL, AND NEURO-THERAPEUTIC RELATIONS.

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BY

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1894.

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TO MY

MATERNAL UNCLE,

FREDERICK DEMING,

AS A TOKEN OF ADMIRATION
AND AFFECTION.

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PREFACE.

"Pains are the correlatives of actions injurious to the organism, while pleasures are the correlatives of actions conducive to its welfare."—HERBERT SPENCER, *Principles of Psychology*.

"The phenomena of feeling constitute the true basis of all that part of philosophy which at all involves the interest of man."—LESTER F. WARD, *Dynamic Sociology*.

THERE is no department of neurology a knowledge of which is so essential to the physician as that which deals with pain. As an aid to diagnosis the importance of this symptom is unique; while to relieve it requires discernment and ingenuity of a high order.

Nor is its ethical significance less apparent; for surely there is nothing in all the world so conducive to an active sympathy with mankind as the habitual relief of suffering.

Since, during the past ten years, the author has devoted much time to the study of pain, he is led to hope that in presenting this volume he may be able to advance in some degree the cause of scientific medicine.

53 WEST THIRTY-EIGHTH STREET, NEW YORK.
March 1, 1894.

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PART I.

PHYSIOLOGICAL, PATHOLOGICAL, AND CLINICAL.

CHAPTER I.

THE PHYSIOLOGY OF PAIN—CONDUCTION—DEFINITION.

Definition of Pain.—Various attempts have been made to define pain. Cicero looked upon it as a disagreeable movement within the body, independent of the senses. According to others, it is a species of sensation which may emanate from both internal and external regions of the body, in which are distributed nerves, "whose office it is to transmit to the brain all impressions." Sauvage calls it a disagreeable perception, originating from any lesion of the nerve-fibres; Gaubius regards it as a sensation which the mind "would rather not experience" (!); while Bilon is discontented with all definitions, and believes the word pain to be so universally descriptive in itself as to enable one to dispense with

all definitions.[1] More recent authors have, nevertheless, persisted in further attempts to define it. Thus Valentin[2] perceives in pain "sensory impressions which, on account of their too great intensity, become disagreeable;" Wundt[3] calls it "a feeling that accompanies all powerful or intense stimuli," while Eulenburg[4] defines it as "a gradual increase of the feeling that accompanies every sensory process."

To my mind, the views of Erb[5] regarding the nature of pain are among the most comprehensive which have been recently expressed. "We hold," he says, "that every increase of ordinary sensory stimuli is capable of producing pain, as soon as it attains a certain intensity. Every excitation, the intensity of which exceeds certain limits, every molecular change of the centripetal series, induced by an abnormally strong stimulus, is perceived as pain. Very simple experiments, as, for example, pressure or temperature gradually increased till pain

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[1] Dictionnaire des Sciences Médicales, vol. x. p. 179, Paris, 1814.

[2] Physiologische Pathologie der Nerven, vol. i. p. 240.

[3] Lehrbuch der Physiologie des Menschen, p. 503, 1874.

[4] Functionelle Nervenkrankheiten, p. 31. *Vide* also Diseases of the Peripheral Cerebro-Spinal Nerves, by Wilhelm Heinrich Erb, Ziemssen's Cyclopædia, vol. xi. p. 14.

[5] Op. et loc. cit.

is produced, show that, with very gradual increase in the strength of the stimulus, a limit is at length reached beyond which the excitory process is accompanied by pain, yet no sharp line of demarcation can be traced defining the point at which the sensation of pressure or temperature ceases and the sensation of pain commences."

Regarding, then, the phenomena concerned in their broadest aspect, I would define pain as the feeling (perception) evoked by over-stimulation of the nerves of special and common sensation. By over-stimulation is meant, of course, a degree of stimulation which exceeds the physiological limit.

We have thus a clue to the genesis not only of those pains which originate in over-stimulation of the nerves of common sensation, with which we are most frequently called upon to deal, but of those likewise which have their origin in an exaggerated stimulation of the nerves of special sense; for do we not know that intense light and loud inharmonious noises produce sensations which are described by those subjected to them as veritable pains?

In view of these facts, nothing can be more inconsistent—to give it no stronger name—than the attempts of those extremists whom Brown-Séquard has facetiously alluded to as the "cluster localizers" to ascribe the perception of pain to a limited area

of the cortex. Clearly, a hypothetical spot of this kind could by no possibility serve as the rendezvous for the pain-concepts of both special and common sensation.

Such a centralization of heterogeneous functions is physiologically, not to say anatomically, unthinkable.

From all this it is evident, then, that the modification engendered in the perceptive mechanisms of common and special sensation by excessive stimulation is the principal, if not the only, prerequisite to the development of pain.

As regards those fine molecular perturbations originating in the nerve and transmitted thence to the sensorium,—perturbations which are evidently the ultimate and essential element of pain,—we are still, and doubtless are destined in future to remain, entirely in the dark. Although we are thus debarred, on account of the crudity of our physiology, from penetrating the final mystery of pain, we are, nevertheless, enabled to adopt proper means for its arrest when once established.

As the argument proceeds, we shall find that, in combating pain, we are compelled to invoke the aid of a wide range of agents; and thus it happens that chemistry, thermo-dynamics, physics, and even surgery have all rendered important assistance.

Finally, we must not forget to mention a very recent theory regarding the mechanism underlying the pains occurring along the course of nerves. According to Prus,[1] who is the promulgator of this theory, there are filaments in the sheaths of nerve-trunks the irritation of which gives rise to the painful points found in neuralgic affections. These filaments, the presence of which was made known by careful microscopical examination, have received the somewhat ponderous appellation of *nervi nervorum periphericorum.*

It is, of course, impossible at present to prophesy with any degree of certainty what part these structures are destined to play in the physiology and pathology of the future. Perhaps autopsies conducted with a special view to further enlightenment on this point may afford assistance; but it is hardly to be anticipated that we shall derive much help from experimentation.

The Transmission of Painful Impressions from the Periphery to the Perceptive Mechanism.—The next question which naturally suggests itself is, how do painful impressions reach the higher centres of the brain? or, in other words, along what paths do such impressions travel in their journey from

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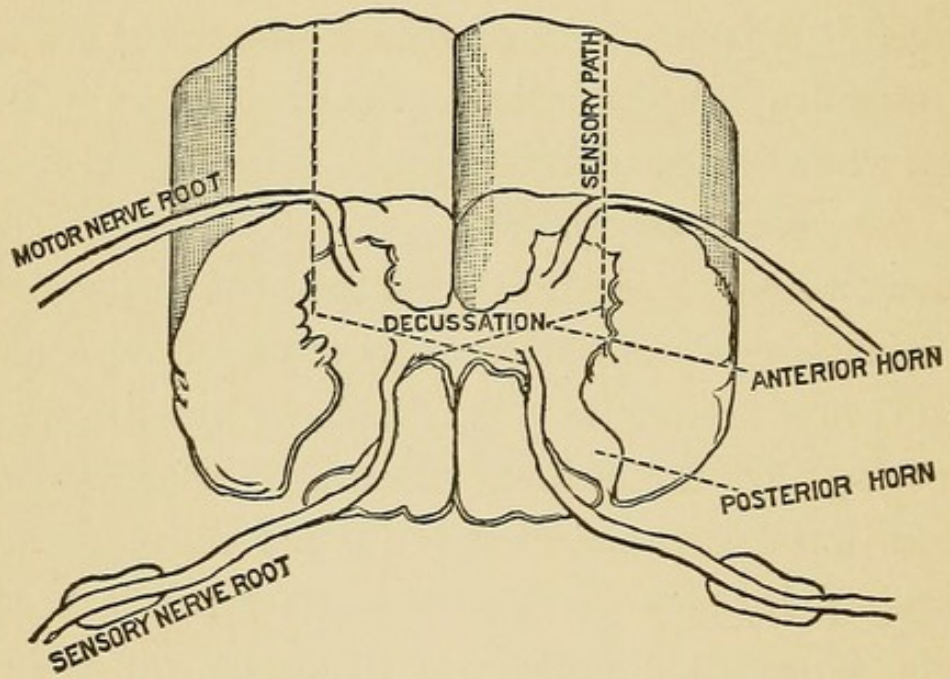
[1] Archives Slaves de Biologie; also Brain, vol. x. p. 557.

the periphery to the mechanism ("centre") of conscious perception?

It is much to be regretted that only a partial answer can be given to this important question.

About all we know of the matter is soon told. In the first place, as every one knows, the trans-

FIG. 1.

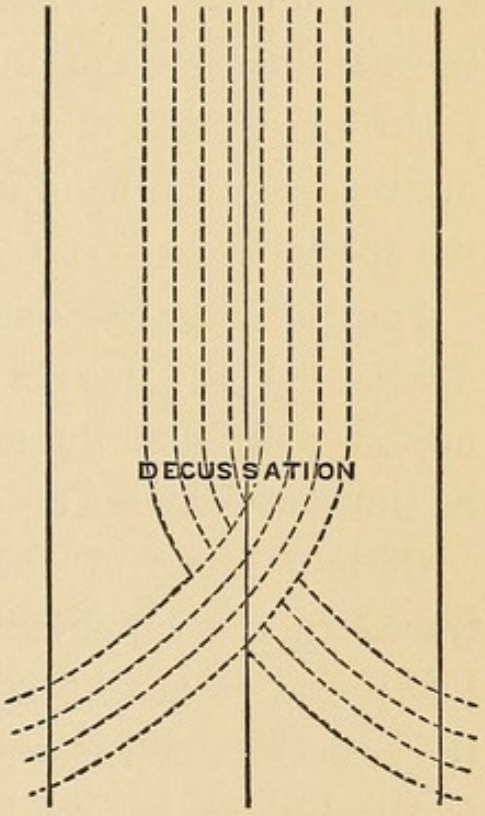


mission of painful sensations from the periphery to the spinal cord is accomplished through the instrumentality of the sensory nerves. The course pursued by such painful impressions through the cord is more obscure. Some physiologists believe that, after crossing to the opposite side of the cord, they are transmitted wholly through the gray substance; others, again, assign special importance to the sensory conducting paths of the posterior columns;

while a third class of observers believe that sensations of pain may be transmitted both through the gray substance and the white substance of the posterior and lateral columns.

But while the direction pursued by the sensory pathway *after* crossing in the cord is not altogether clear, the decussation itself seems adequately demonstrated. Evidence of this intersection of the fibres is afforded by the fact that, when one lateral half of the cord is divided transversely by traumatism or disease, the parts below it on the same side are paralyzed, while sensation is lost in the corresponding parts on the *opposite* side. Thus it is that sensory fibres from the right half of the body cross the median line and ascend in the left half of the cord, while those from the left half of the body decussate and pass upward on the right side of the cord. The decussation of the sensory fibres in the cord is indicated in the diagrams,—Fig. 1, transverse, and Fig. 2, longitudinal, section.

FIG. 2.



Our knowledge of the route pursued by the sensory fibres through the medulla oblongata and the pons is quite indefinite, and the same may be said of the relation which these tracts sustain to the gray matter of those regions. From the data available, it would seem, however, that sensation is transmitted onward through the tegmentum to the hindermost portion of the posterior limb of the internal capsule, and thence, by way of the corona radiata, to the cerebral cortex. At its point of transit through the internal capsule the sensory pathway seems to lie in close proximity to the fibres destined for the conduction of the impressions of the special senses.

The Sensory Regions of the Cortex.—The evidence that the nerves of special sense are connected with definite areas of the cerebrum may be thus summarized:

Certain fibres of the olfactory tract have been traced to the hippocampal gyrus in the temporal lobe; and it has been observed that keenness of the sense of smell is materially lessened after lesion of the hippocampus. The so-called "taste centre" has been located in the temporal lobe in the vicinity of that of smell; but the evidence in favor of assigning it to this locality is inconclusive. Nor is the location of the auditory centre altogether cer-

tain, in spite of the attempts to associate it with the superior temporal convolution. Some of the phenomena bearing on the question are, however, sufficiently interesting to deserve mention.

In the first place, it has been observed that, after destruction of the internal ear, the median corpus geniculatum and posterior corpus quadrigeminum atrophy; and, secondly, atrophy of the nuclei may be induced by destroying the superior temporal convolution. Additional experiments and pathological investigations are required to establish this somewhat complicated connection.

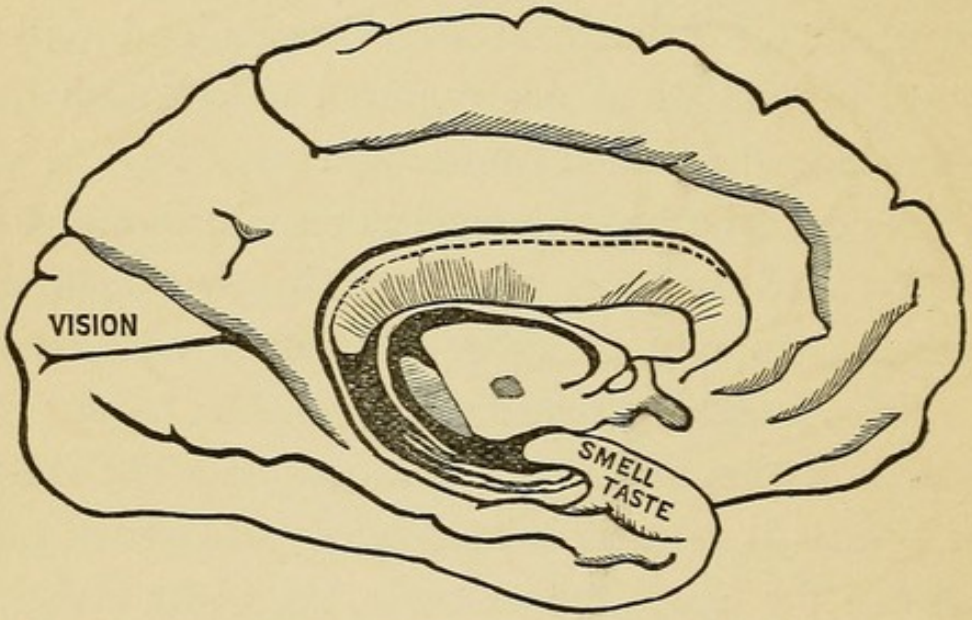
The cortical area concerned in visual perception—the so-called optic centre—is much more definitely located than any of those previously considered. It seems, indeed, exceedingly probable, to say the least, that that portion of the occipital lobe called the cuneus is intimately associated with visual perception; for when, for example, the right occipital lobe is removed or rendered inoperative by disease, left hemiopia results, and *vice versa*, while the obliteration of both occipital lobes gives rise to total blindness.

There are other collateral facts bearing on the question, such as the secondary atrophy of the pulvinar of the thalamus, the lateral corpus geniculatum, and the median corpus quadrigeminum

after extirpation of the occipital cortex, but the essentially practical scope of this work precludes their consideration.

An immense amount of discussion has been lavished on the question as to what portions of the cerebral cortex are associated with cutaneous sensation. In my opinion, the evidence at present available—though certainly to some extent con-

FIG. 3.



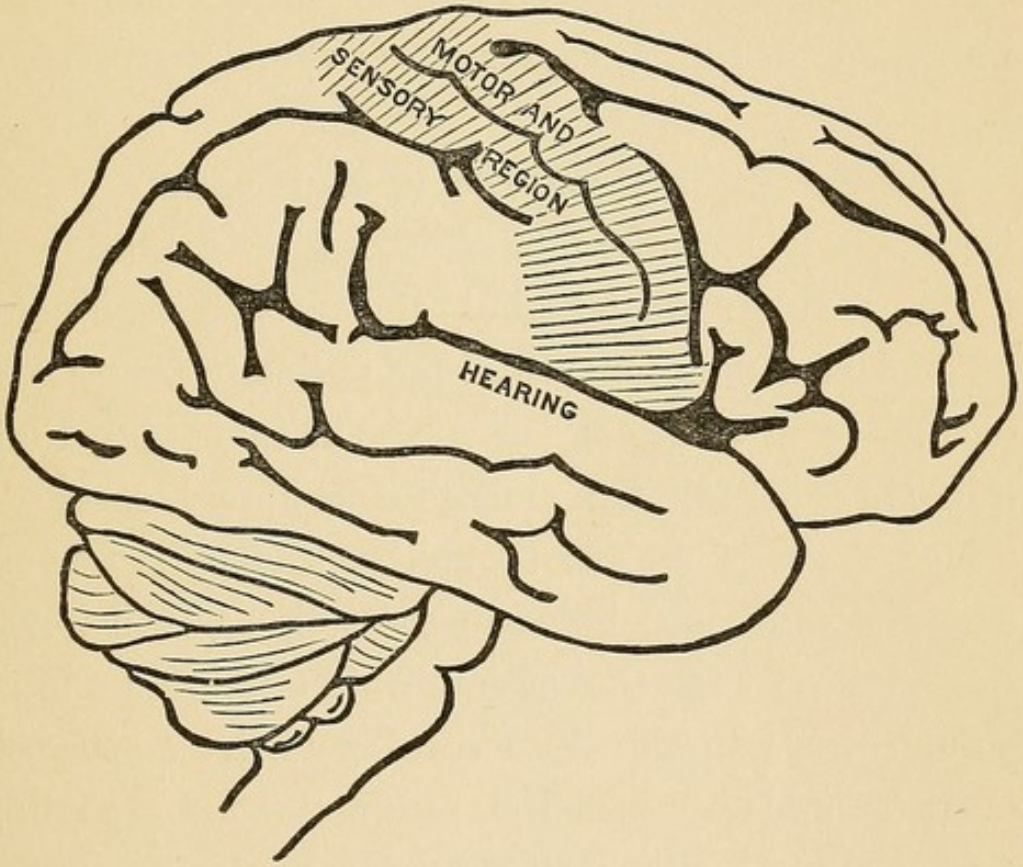
flicting—goes to show that the so-called "sensory centres" are distributed throughout the "motor area," if indeed they do not extend beyond it.

It is a well-known fact that irritation of the sensory nerves of the skin may produce several kinds of sensations; or what amounts to the same thing, these nerves are endowed with different kinds of sensibility.

Thus, we have a sense of locality, tactile sensibility, sense of temperature, "sense of pain," and sense of pressure, according to the mode of action of the peripheral irritant.

In certain diseases of the nervous system some or all of these powers of discrimination may be im-

FIG. 4.



paired or lost; so that from a diagnostic point of view the investigation of cutaneous sensibility is a matter of importance. Whether—as has been alleged and as some facts tend to show—each variety of cutaneous sensibility is provided with a

separate and distinct pathway is, however, still an open question.

The regions previously discussed are shown in the annexed diagrams. The hypothetical areas ("centres") of vision, smell, and taste, as viewed from the mesial aspect of the brain, are shown in Fig. 3, while the sensori-motor region and the locality supposed to be associated with hearing are indicated in Fig. 4, representing the right cerebral hemisphere.

Identity of the Processes in Motor and Sensory Nerves.—It has often been asked, as a matter of theoretic interest, whether the processes accomplished in a motor nerve differ radically from those occurring in a sensory nerve. On this point, Radcliffe, in concluding an elaborate argument, observes, "that there is reason to believe that there is no essential difference between the action which issues in sensation and the action which issues in muscular contraction." As a corollary to this proposition, he adds: "that the production of sensation and the production of muscular contraction only differ in this,—that the electrical discharge, analogous to that of the torpedo, which is developed in and near the nerve in the state of nervous action, happens to tell upon sensorial ganglionic cells in the one case, and upon muscular fibres in the other."

Of course to speak of the electricity evolved during the action of a nerve as though it were the nerve-force concerned in the production of sensation or motion is a mistake. In other respects, the figure is an apt one.

It may be of interest, in this connection, to consider the experiments which have led Radcliffe and others to these conclusions. Undoubtedly the researches of Du Bois Reymond and Matteucci have had a powerful influence in shaping opinion.

The principal experiment of Du Bois Reymond consists in pouring hot water upon the leg of a frog, the nerve of the same being connected with a galvanometer. When this is done, the galvanometer shows a cessation of the electrical current,—a phenomenon which is observed almost as soon as the water touches the integument. This observation in conjunction with the well-known fact that there is also a decrease, amounting sometimes to almost entire absence of "natural electricity," during the action of motor nerves, led Du Bois Reymond to the inference that in sensory as well as motor nerves there is a loss of electricity when the nerves pass from rest into a state of action.

Matteucci's experiment, performed upon a rabbit, consisted in dissecting out the upper portion of the sciatic nerve and in irritating it with the galvanic

current. When the current was closed the animal screamed loudly, but when it was opened there was no sign of pain.

The resemblance of the phenomena evoked by the galvanic current in sensitive and motor nerves has led to the inference that the change in a sensory nerve when sensation is produced by the action of voltaic electricity, and the change in a motor nerve when muscular contraction is produced by the same means, are, as Radcliffe puts it, exact equivalents.

Such, then, are the principal facts which have been assumed to prove the identity of the processes underlying the actions of motor and sensory nerves. While, however, the relation of the two kinds of nerves to the galvanic current points to the truth of this proposition, it is, of course, self-evident that the *final result* of the action differs radically in each kind of nerve. In the case of the motor nerve, action results in contractions, due to the excitation of the contractile substance of the muscle; in the case of the sensory nerve, on the other hand, action is translated into perception, through the instrumentality of the central ganglionic apparatus in the cortex.

So much for the fundamental features of the argument.

Concerning the Correct and Erroneous Reference of Painful Sensations.—While all are aware of that remarkable attribute of the perceptive mechanism which usually enables the individual to refer with great exactness both agreeable and disagreeable sensations to their point of origin at the periphery, few comparatively have given thought to the anatomical arrangement underlying this phenomenon; and fewer still are able to account for those apparent paradoxes, which obscure the physiology involved and tend to discredit its application in the clinic. Hence we shall not, I believe, misuse our time if we devote a few paragraphs to a review of the more important points connected with referred sensations.

In the first place, then, it must be remembered that a sensory nerve supplies a certain area of the body and transmits to the brain only such impressions as emanate from that area. In other words, there is no physiological anastomosis, however much the fibres may interlace or run together. To prove this, it is only necessary to divide a sensory nerve and irritate its distal end, when we find that no sensation is perceived, thus demonstrating that there is no collateral communication whatsoever. As a matter of course, irritation of the proximal or central portion of the nerve—that part which

is connected with the nerve-centres—gives rise to distinct sensation.

In the same way, if we divide the spinal cord of an animal transversely, so as to sever the sensory conducting paths, and irritate the nerves which join the cord below the incision, no sensation will be perceived; but if we stimulate the nerves which enter the cord above the incision, we shall have every evidence that the sensation has been perceived. Precisely the same sort of phenomena may be observed in human beings who by reason of injury or disease have suffered a solution of the sensory conducting paths of the cord.

Another important fact is, that an impression made upon any point in the course of a sensory nerve may be perceived by the mind as though it were made not only upon the point in question, but also upon the part to which the fibres of the nerve are distributed. We have, therefore, under such circumstances, practically the same effect as if the irritation were applied to the regions supplied by the branches of the nerve.

An explanation is thus afforded of the fact that when the sensibility of a part is abolished by compression or division of the nerve which supplies it, irritation of the central portion may still give rise to sensations which are felt as though they emanated

from the parts below the point of interruption,—*i.e.*, from the parts to which the peripheral terminations of the nerve are distributed. Thus, when a nerve is divided for the cure of an intractable form of neuralgia, it sometimes happens that pain still persists. This is undoubtedly due to the fact that the division of the nerve has not been made near enough to the nerve-centres to include the entire affected portion, and hence the continued irritation of the central portion causes pain, which, in accordance with the law under consideration, is felt as though it emanated from the peripheral parts of the nerve. Another illustration of the same thing is found in those paralyses in which the limbs are quite insensible to such external stimuli as pricking, pinching, and burning, and yet are believed by the patient to be the seat of severe pain. Still another example of erroneously referred pains is seen in persons who have suffered amputation of a limb. When the divided nerves of the stump are inflamed, or otherwise irritated, nothing is more common than to hear the subject complain that he experiences pain which appears to be located in the part of the limb which has been removed.

Such facts as these might, on a superficial examination, lead one to suppose that there was little or no benefit to be anticipated from local therapeutic

measures addressed to the affected nerve itself in cases of pain. It must be remembered, however, that by the aid of chemicals we are in many cases able not only to temporarily cut off the peripheral portion of an affected nerve from its central connections, but also to modify the abnormal condition of the nerve itself, thus accomplishing an abolition of pain which is often permanent. From this it follows that we can deal much more effectively with circumscribed neuritis and congestion by the aid of local remedies than with diffuse inflammation of the nerves, which can only be reached by remedies acting through the general circulation.

CHAPTER II.

THE PATHOLOGY OF PAIN—NEURITIS, OR INFLAMMATION OF THE NERVES.

As inflammatory conditions of the nerves constitute the most prolific source of pain, it is necessary to possess a general knowledge of the more common, and hence important, forms of neuritis.

General Considerations.—The whole subject of neuritis, and particularly the part of it which relates to multiple neuritis, has received a vast deal of attention during the last few years. These studies—many of them at least—are important, not only on account of their immediate clinical bearing, but also because of the light which they have already shed and are destined in future to shed upon many disputed points in neuro-pathology. Let me illustrate this point. Up to a comparatively recent period most of the text-books contained a more or less elaborate description of a form of paralysis the chief features of which are a motor paralysis which usually begins in the legs and spreads rapidly over the trunk to the arms. As a rule the medulla ob-

longata is involved, and there is usually, though not invariably, more or less fever. General sensibility and the functions of the bladder and rectum are but slightly affected; there is no notable atrophy of the muscles, and consequently no diminution in the electrical excitability. Now, this acute ascending paralysis, or "Landry's paralysis," as it has often been called in recognition of the accurate description which this writer was the first to publish, was for a considerable time almost universally classified among the diseases of the spinal cord, and this in the face of the fact that pathology afforded little or no justification for such a step. It is not to be wondered at, therefore, that in default of tangible changes in the cord pathologists should ultimately have sought elsewhere for lesions of sufficient extent to account for the symptoms. Nor is it surprising that they should have turned their attention to the nerves, since by assuming a more or less general disturbance of these organs the symptoms—or at least most of them—might be logically accounted for. Thus it happened that as soon as the etiology and symptomatology of neuritis, and more especially general neuritis, had become more thoroughly understood, neurologists were not slow to perceive the parallelism which exists between this affection and the group of symptoms heretofore known as

Landry's paralysis. So impressed is Ross with this resemblance that he has undertaken a most exhaustive study of all the cases of Landry's paralysis to be found in literature. From an analysis of these cases (ninety-three in number) he concludes that Landry's paralysis is simply a variety of multiple neuritis. In this he agrees with the general deductions of Barth and Nauwerck, who have also conducted some important studies in the same field. The literature of the subject has also received copious additions from other sources.

Before, however, pursuing this subject of multiple neuritis further I shall take the liberty of offering a few remarks on the simple or local form of nerve inflammation.

Simple Neuritis.—The most frequent causes of this local form of neuritis are wounds, inflammatory conditions in the vicinity of the nerve-stem, rheumatic influences culminating in thickening of the sheath, and tumors pressing upon the nerve. Severe compression of the nerve, caries of neighboring bones, and bruises may also give rise to it. To sum up the whole question of etiology, it may be stated that the restricted form of neuritis is more apt to be due to local than general causes; while of multiple or general neural inflammations the reverse is true; for toxic agents acting

more or less extensively throughout the organism play a prominent part in their causation.

Symptoms.—The duration and course of simple neuritis is subject to a certain degree of variation. Usually, however, the onset is quite abrupt, although a gradual beginning is occasionally observed. An initiatory chill and fever are a feature in some cases, but the majority begin without these warnings.

Whatever the precise mode of onset may chance to be, the first symptom to excite the apprehension of the patient is pain. This pain is usually severe, and is felt more or less throughout the distribution of the affected nerve. On applying gentle pressure along the course of the nerve, the latter is found to be extremely sensitive; and after the trouble has continued a certain length of time, it is often possible to feel the nerve—which has become considerably thickened—through the integument.

Though the pain is more or less persistent, it sometimes abates, but only to return again with renewed intensity.

I have under my care at this time a patient in whom the intermittent and severe type of neuritic pain is well illustrated. The patient, a lady of high social position, was recently referred to me by Dr. M. S. Ayers, of New Jersey, for severe brachial neuralgia. On examination, I found the region

along the course of the brachial plexus exceedingly sensitive to the touch, and the whole right arm hyperæsthetic.

Desiring to ascertain a possible cause for the neuritis, I investigated the case with considerable care, the patient herself aiding me in every way by her prompt and intelligent replies. Without entering into unnecessary details, let me say that my attention was early directed to a swelling situated in the space above the clavicle immediately adjoining the neck. This tumor was somewhat compressible; there was pulsation,—whether external or internal I could not tell,—and the region round about, and more especially at the anterior border of the enlargement, was quite tender to the touch. The point of interest, however, from an etiological point of view, was the fact that whenever the tumor was pressed upon, even to a moderate degree, the most excruciating pains were evoked in the region of the brachial plexus, and indeed throughout the entire arm. This left no doubt in my mind that the neuritis had been set up by the pressure of the tumor. Being in doubt, however, as to the nature of the latter, I called in consultation my friend Dr. John A. Wyeth, who, after a most thorough examination, expressed the belief that the tumor was either a subclavian aneurism or a malignant tumor.

An operation having been decided upon, Dr. Wyeth cut down upon and extirpated the tumor, which on microscopical examination proved to be a sarcoma. Being closely adherent to the nerve, which it compressed, this tumor had given rise to a local neuritis of great severity. The patient made an excellent recovery, and there has been no return of the tumor.

Disturbances of sensibility and motility also occur in neuritis as the direct result of interference with nervous conduction. Tingling, numbness, and a moderate degree of anæsthesia are observed in cases of medium severity; while in those characterized by more extensive and permanent changes in the nerve the anæsthesia may be profound. The magnitude of the motor derangements is also determined by the vehemence of the neuritis: when the destruction in the nerve-fibres is of moderate extent, the subject merely complains of weakness; but when the mischief is more serious, conduction is abolished; the muscle is paralyzed, and eventually atrophies more or less extensively. At the inception of the atrophy the characteristic electrical reaction of degeneration may be obtained, so that a reliable prognosis may be given before the wasting is at all pronounced.

Finally, extensive changes in the skin have been

observed in a certain number of cases. The most common are vesicular and herpetic eruptions, glossy skin, and atrophy. The hair and nails may likewise be affected, the former becoming brittle and the latter stubby.

Prognosis.—No very definite rules can be laid down as to the duration of the disease. Sometimes the symptoms are acute in character, attaining their maximum degree of development in a short time. In other cases the progress of the disease is insidious from the very beginning, there being neither chill, fever, nor an extreme degree of pain to mark its inception. Again, there may be an acute beginning and a rapid display of symptoms; or the outbreak of the disease is acute, while the evolution of symptoms is gradual. The latter cases belong in the category of so-called *chronic neuritis.*

Whatever the particular mode of development may chance to be, the life of the patient is but rarely in jeopardy, and then only when the neuritis evinces a tendency to pursue an ascending course, in which cases important structures in the cerebro-spinal axis may be destroyed. In acute cases the recovery may often be exceedingly rapid, cessation of the inflammatory process and regeneration of the affected nerve-fibres taking place in an astonishingly short time. The residual mischief in a case of this

kind is insignificant. On the other hand, the chronic cases often last for months, and, even where recovery is apparently complete, there is always danger of relapse.

Of course the presence of persistent and widespread atrophy of the muscles is unfavorable. In cases of this sort there is inevitably more or less pronounced impairment of motion.

Pathology.—When the course of the disease is acute, the pathological changes are proportionately vehement. The affected nerve is seen to be reddened, swollen, and thickened; its vessels are distended and intensely hyperæmic, to which circumstance the lividity is due; there is a transudation of cellular elements and fluid from the engorged vessels into the interstitial tissue and nerve-sheaths; and, in short, we have a typical picture of acute inflammation. On examining the nerve-fibres more closely, by the aid of good lenses, we find that the destructive process is by no means as far advanced in some as in others. In those which present the most marked changes the axis cylinder is completely obliterated, the medullary substance undergoes fatty or granular degeneration, and the sheaths themselves are more or less disintegrated. Finally, the disorganized remnants may be to a greater or less degree absorbed, and then

nothing remains behind but the empty sheaths. This, as previously mentioned, is the course of events in the more severe cases; in those of a milder type, however, the changes are less far-reaching, nothing more than moderate swelling of the sheath and granulation of the medullary substance being discoverable.

Finally, cases which begin in a chronic manner do not present the primary stage of engorgement of the vessels and fluid and cellular infiltration.

It has already been noted in the clinical portion of this chapter that some cases of a severer type get well without loss of power, provided the muscular atrophy has not been too extensive. This fact presupposes that the regenerative capacity of the peripheral nerves is prodigious. Considerable difference of opinion exists among pathologists as to the manner in which this restoration of the nerve-filaments takes place. Of late, however, two theories have chiefly claimed attention. According to the one, new axis cylinders are evolved and prolonged from those which have escaped the ravages of the inflammation; while the other affirms that the young nerve-fibres are derived "from an endogenous growth of nuclei within the Schwann's sheath." Beneke and Neumann are adherents of this hypothesis.

In connection with traumatic neuritis the facts bearing on the regeneration of divided nerves are strikingly exhibited; for, from what has been learned both experimentally and in the clinic, it is certain that more or less perfect union and restoration of function may be obtained in nerves which have been considerably mutilated.

Thus, Gluck found, in the course of a series of experiments on fowls, that excision of a piece of nerve was not followed by restoration of function, but that, after simple division, such restoration readily took place when the ends were carefully coaptated. This renewal of conduction was, moreover, established with marvellous rapidity,—in two instances in twenty-four hours. As a rule, however, when the sciatic was divided and the ends immediately joined with sutures, paralysis of the muscles supplied by the nerve persisted for fifty hours. After the lapse of this interval there was a gradual resumption of motion in the affected muscles, more or less complete recovery taking place in about four days.

Waller and Vaulair believe that the regeneration takes place from the central end of the divided nerve, and that the peripheral end degenerates. Tizzoni, on the other hand, holds that the degeneration affects both ends of the nerve at the point of incision.

Eichhorst and Mayer maintain that the reorganization takes place from the nerve-fibres on both sides of the incision, the new connecting fibres being derived from the axis cylinders; while Ranvier has indicated the important part played by the mechanical support of the tissues in maintaining the physiological distribution of regenerated nerves. In my opinion, the regeneration of the nerve is effected, or largely effected, from the central end, substantially as described by Waller and Vaulair.

Lastly, Paget has found that after division of the median nerve sensation began to appear in the regions supplied by it within two weeks. Recovery was practically complete in about four weeks. As has already been said, the accurate coaptation of the ends of the nerve at the point of division favors cicatrization and regeneration, and hence the frequency and success with which the process has been resorted to by modern surgeons.

From the above data it is evident that considerable difference of opinion exists among pathologists regarding the remarkable series of events which culminate in the restoration of function in a nerve previously injured either by the knife or the inroads of active inflammation. Nevertheless, many of the phenomena observed are exceedingly suggestive, and it is, moreover, highly probable that some at

least of the points in dispute will be definitely settled in the near future.

The measures applicable in the management of neuritis are such as tend to reduce the inflammation and allay the pain. Of the former, local measures, such as hot applications, vesicants, and rest, are of the first importance. In addition to these, some authors recommend cold, applied either by means of the ice-bag or rubber coil. For my own part, I much prefer heat, which I am in the habit of employing in the form of cloths, which have been previously dipped in hot water and then carefully wrung out before wrapping them about the affected limb. Blisters, too, undoubtedly do good, especially in the less acute cases; and, indeed, the same may be said of galvanism, which often sensibly moderates the feeling of soreness, possibly by diminishing the hyperæmic condition in and about the nerve-stems, or merely by exerting a counter-irritant effect.

Rest has also been spoken of; let me once more insist upon its great importance; for nothing in the mode of life of the patient should be tolerated which allows or compels him to move about a limb which is the seat of neuritis. It is, indeed, advisable to insist upon his remaining in bed when a lower limb is involved, or upon the application of a sim-

ple splint or sling when the nerves of the arm are affected.

Lastly, there should be no hesitancy in invoking the aid of analgesis in order to control the severe paroxysms of pain which are so characteristic of the disease. Morphine in moderate doses, especially when combined with phenacetin or antipyrin, sometimes answers; but, as a rule, it is necessary to give the former remedy in large doses, of from one-quarter to one-half grain, in order to obtain appreciable relief. In the section devoted to the general principles of treatment the application of remedies will be more fully considered.

Multiple Neuritis.—In this form of neuritis we have to do with a symmetrical and more or less widely disseminated inflammation or degeneration of the sensory and motor nerves, particularly the latter. As a rule, the cerebral and bulbar nerves are little or not at all affected. Since Dumenil published his excellent paper in 1864, a multitude of observers have come forward; and, indeed, hardly a year goes by without witnessing extensive additions to the literature of the subject. At the present time the available material is quite overwhelming, so that detailed references to it would only tend to add confusion to a subject already sufficiently involved. I shall, therefore, content myself with a

more general method of presentation, leaving the reader to work up for himself such points as he may be specially interested in.

To begin with the etiology, it is necessary to bear in mind that disseminated inflammation of the nerves may be induced by an extensive array of causes, among which toxic and infectious agents occupy a conspicuous position. Prominent among these are lead, alcohol, illuminating gas, bisulphide of carbon, arsenic, aniline, dinitro-benzine, phosphorus, mercury, morphine, and ergot; and among animal and endogenous poisons fevers of various kinds, diphtheria, tuberculosis, beriberi, leprosy, malaria, *la grippe* (influenza), and gout, rheumatism, the puerperal state, chorea, and diabetes. In addition to these, dyscrasic conditions undoubtedly play a part in the evolution of certain cases. Thus, an attack of neuritis is a frequent concomitant of diseases of the blood-vessels, marasmus, chlorosis, and cancer.

A large proportion of cases begin acutely, a smaller number develop more gradually, while a third class display great lethargy in the evolution of the different symptoms. Hence it is customary in some of the books to describe an acute, a subacute, and a chronic form of the disease.

Besides these varieties, Ross, who has recently published a series of most exhaustive papers on the subject, introduces some other forms in his classification. Sensory, vaso-motor, and trophic neuritis, as well as the irritative form,—which includes professional hypercinesia and tetany,—are assigned a prominent place in his classification. Under the head of sensory neuritis he places the so-called *neuro-tabes peripherica*, or that form of neuritis which occurs in ataxia; Weir Mitchell's neurosis (erythromelalgia) is classed as a vaso-motor neuritis; and, finally, Raynaud's disease is the representative of the trophic form of neuritis. The latter part of this classification of Ross—more especially that which relates to tetany—has not yet met with general acceptance, largely on account of the meagre support which it has thus far received from pathology. With this exception, the classification leaves nothing to be desired.

It would be a simple waste of time to enter into a separate description of all these different forms of neuritis; for, however they may differ in causation, they all display a remarkable family likeness. For this reason I shall endeavor to give a general account of the disease, embracing all its more characteristic features, by the aid of which I trust the reader will be able to arrive at a diagnosis, even

when the complicating factors in a given case are considerable.

General Symptoms of Multiple Neuritis.—Quite a large proportion of cases of multiple neuritis, of whatever cause, begin abruptly. It is true that the patient may complain for some days of vague feelings of malaise and weakness, especially in the lower limbs; but these sensations commonly excite little or no attention, and not until more definite symptoms are added is medical aid invoked. At this time he suffers perhaps from vague discomfort in the head, loss of appetite, and mental hebetude, and he may even be delirious. There may also be considerable fever, the temperature reaching 101° or even 105°, while the pulse is correspondingly accelerated. Sometimes, however, the evolution of the symptoms, even in the beginning, is more gradual, and it is then quite difficult to predict what is really impending. Whatever phase these premonitory phenomena may assume, however, they are certain, or almost certain, to be speedily followed by symptoms of sensory irritation. The subject complains of tingling, numbness, crawling sensations, and pain. These symptoms are especially pronounced in the affected limbs, and they evince, as may readily be imagined, a decided predilection for the regions in the vicinity of the nerves. While

sensory irritation is apparent from the beginning, the opposite condition of sensory paralysis is by no means so obvious. It is true that the muscular sense may be so impaired as to give rise to pronounced ataxia; the tactile sense, too, may be more or less affected, and the transmission of sensations of heat and cold, as well as those of pain, may be considerably retarded. Still, it must be borne in mind that, when the sensations reach the central, perceptive mechanism, they possess considerable vigor, and are therefore felt with great distinctness. Complete anæsthesia then is decidedly exceptional.

The distribution of these paræsthesiæ is a matter of some interest. Sometimes they are associated with the ramifications of a particular nerve, while at others they are distributed in irregular islands without obvious physiological connection; or, finally, they may pervade the entire limb. In any event, their presence is significant and often of the first importance in forming a correct diagnosis.

The pains, too, when taken in connection with the other features of the case, are of value in forming an opinion as to the nature of the disease. Though somewhat like those of locomotor ataxia, they differ notably in this,—that whereas in multiple neuritis the pains are readily evoked by pressure upon the nerves, this is not usually the case in

ataxia. With the advent of these pains there is sometimes more or less œdema, profuse diaphoresis, or swelling of the joints; this is especially true of the epidemic variety of neuritis. The last-named symptom has frequently caused the case to be mistaken for acute articular rheumatism.

Not less important than the sensory symptoms are the derangements of motility. The latter, unlike the former, are non-irritative in type, paralysis of motion being the rule, while spasms are rare. In the majority of cases the paralysis begins first in one leg, speedily involves the other, and may advance thence to one or both arms. As a rule, the invasion is rapid, the loss of power beginning as a simple sensation of weakness on standing or walking, and culminating in more or less complete paralysis in fifteen or eighteen days. The distribution of the paralysis presents some points of interest. In the first place, it is a remarkable fact that the muscles concerned in the manipulation of the small joints of the hands and feet and of the wrists and ankles are much more affected than those of the elbows and knees. Thus, in a case which I recently saw in consultation with Dr. Eleanora Haines, of Newark, the patient, a man of sixty, who was a sufferer from multiple neuritis of malarial origin, was able to move both elbows and knees without

difficulty, while voluntary motion in the wrists and ankles was quite impossible. Another interesting point is, that the paralysis shows quite an irregular distribution at first, but assumes the characteristic form when fully developed. I emphasize this point because one who sees the case at the commencement of the paralytic invasion is apt to be puzzled, unless forewarned of the erratic course of the symptoms.

Such, then, is the course of events in an ordinary case of neuritis. Exceptionally, however, the clinical picture is considerably modified. Thus, as a rule, the cerebral and bulbar nerves are not involved; and yet, in fatal cases, the pneumogastric is invaded, deglutition becomes difficult, and the patient dies as the result of complications analogous to those of bulbar paralysis. In another and smaller class of cases some of the cranial nerves—notably those of the eyes, and more rarely those of the face—become implicated. Lastly, in a larger number, the paralysis extends to the muscles of the trunk, and those of the arms and thighs as well. Such cases are liable to prove fatal on account of the implication of the muscles concerned in respiration; this, indeed, is the most frequent cause of death in the severe multiple neuritis which accompanies alcoholism and the disease known as "kakke," or "beri-

beri." In a large percentage of cases of ordinary type, however, more or less perfect recovery takes place. The precise amount of power regained by the affected muscles will be determined by the extent to which they have atrophied; for, as a matter of fact, such atrophy occurs in the majority of cases which pursue an erratic and chronic course. The tendon reflexes are always lost when the paralysis is at all considerable. On the other hand, the function of the bladder and rectum usually remain unaffected. Such are the more important features of multiple neuritis.

SPECIAL TYPES OF NEURITIS.

CHRONIC ALCOHOLIC NEURITIS—NEURITIS FOLLOWING INFLUENZA—THE NEURITIS OF LEPROSY—BERIBERI.

While the foregoing description affords a general survey of multiple neuritis, there are certain types of the disease endowed with sufficient individuality to justify separate consideration. This applies especially to chronic alcoholic neuritis, the neuritis of leprosy, and the disease known as "beriberi," or "kakke."

Chronic Alcoholic Neuritis, or the Pseudo-Ataxia of Drunkards.—One of the most interesting phases of alcoholic poisoning is that characterized by

symptoms which bear the closest resemblance to those of locomotor ataxia. The disease commonly begins with lancinating pains in the lower limbs; these may or may not extend to the arms; but, in any event, they are usually quite severe. In the course of weeks, months, or even years, the gait of the patient becomes more or less affected. When he attempts to go about, he is troubled by weakness and inability to control the muscles; and a careful examination reveals the fact that there is more or less true paralysis and atrophy combined with the muscular incoördination,—an important distinction, by the way, from true locomotor ataxia. On tapping the patellar tendons, there is little or no response; and the customary electrical tests, when applied to the affected muscles, elicit the reaction of degeneration. In addition to these symptoms, there may usually be discovered more or less extensive zones of anæsthesia in the affected limbs; while pressure upon the nerves shows them to be quite sensitive, though not to the same degree as in the more acute forms of the disease.

This is a fairly complete presentment of the affection as we commonly find it. There are cases, however, in which its complexion is greatly altered. This atypical aspect is largely due to the prominence of the atrophic, paralytic changes, the sensory dis-

turbances remaining quite subordinate from the beginning.

As may readily be imagined, a group of symptoms of this kind may be mistaken for true ataxia, especially in the beginning. Later, the absence of such ataxic symptoms as bladder disturbances, girdling pains, and the Argyll-Robertson pupils, will assist in the formation of a correct diagnosis.

Neuritis following Influenza.—During the epidemics of the "grippe" which have been so common during the last few years, excellent opportunities have been afforded of observing the various nervous disturbances so characteristic of that protean affection.

Among these there are none more interesting than the inflammatory conditions of the nerves, which are the direct result of the systemic poisoning. The symptoms of this form of neuritis resemble somewhat those of the alcoholic form of the disease, if we except the mental manifestations which are absent.

The inflammation is frequently bilateral, invading corresponding nerves on both sides of the body, and giving rise to more or less extensive paralysis and atrophy. When the disease involves both sciatic nerves, as was the case in a man whom I saw in consultation with Dr. G. F. Pitts, of New Jersey,

it may be mistaken for grave disease of the spinal cord; but the exquisite tenderness of the nerves and the absence of bladder and rectal symptoms will usually serve to reveal its true peripheral nature.

Gowers has recently published a highly suggestive paper on this type of neuritis.

The Neuritis of Leprosy.—Although alterations of greater or less extent have been noted in the cerebro-spinal axis, and especially in the cord, in leprosy, these appearances must be regarded as exceptional, inasmuch as many observers have seen them but rarely, while others have altogether failed to find them. On the other hand, nothing is more certain than that inflammations of the nerves, assuming the form of interstitial and parenchymatous neuritis, play an important part in the evolution of many of the symptoms of this dreadful disease. Leloir,[1] in his classical monograph, has given an elaborate account of the genesis of this neuritis. According to his researches, which in their main features coincide with those of Neisser and Hansen, the inflammation of the nerve is due to the virus of the micro-organism of leprosy; for this bacillus

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[1] Traité Pratique et Théorique de la Lèpre, by Henri Leloir, Paris, 1886, p. 248.

is to be found either between the nerve-tubules or in the inflamed interstitial tissue.

To thoroughly comprehend the significance of these changes in the peripheral nerves it is necessary to remember that there are two principal forms of leprosy, the tubercular and the anæsthetic or tropho-neurotic form; and that in the first variety the energy of the disease is largely directed to the integument, while in the second it tends chiefly to the nerves. Between these two extreme varieties various transitional forms occur; so that we sometimes find the tubercular phase of the disease merging into anæsthetic or tropho-neurotic leprosy. This combination of the tubercular and anæsthetic forms is referred to by Leloir as "mixed" leprosy.

Instead of considering the tubercular and transitional phases of the disease, which belong, strictly speaking, in the domain of dermatology, I shall proceed at once to a more extended examination of the anæsthetic or tropho-neurotic form; for it is in the latter that the changes in the peripheral nerves are at once most extensive and far-reaching in their clinical effects. Another reason for examining the phenomena of this form of leprosy more closely is found in the close resemblance which they bear to those of syringomyelia. I shall return to this point later on.

Symptoms of the Anæsthetic Form of Leprosy. —As previously intimated, the symptoms of this form of the disease are all, or nearly all, attributable to the alterations in the nerves. So certain has this become through the combined evidence of the dead-house and clinic that, as Leloir cogently puts it, the study of the anæsthetic or tropho-neurotic form of leprosy is nothing more than the study of a variety of neuritis.

While there is usually no fever in the beginning, the onset of the disease is marked by the occurrence of disturbances of sensibility of various kinds, notably burning, tingling, itching, and hyperæsthesia of the skin. The macular spots of the early eruptive stage are at once pigmented and hyperæmic in appearance. In the beginning of their development they are less livid, but by degrees they merge into gray, brown, or yellow. The subsequent evolution of these patches is thus graphically described by Dr. Prince A. Morrow,[1] who has devoted careful study to the disease as it appears in the Sandwich Islands and among the Chinese of San Francisco. "They are usually persistent," he says, "and mani-

[1] The Diagnosis of Leprosy, especially the Differentiation of the Anæsthetic Form from Syringomyelia, by Prince A. Morrow, M.D., etc., Journal of Cutaneous and Genito-Urinary Diseases, January, 1890, p. 7 *et seq.*

fest a tendency to clear up in the centre while spreading at the periphery. By this mode of centrifugal extension and the coalescence of contiguous patches they form arcs of circles and large gyrate patches, with slightly elevated margins of a reddish-brown, port-wine, sepia, or slaty color."

Upon their first appearance these macules are hyperæsthetic, "but as the central portion closes up the hyperæsthesia recedes to the pigmented periphery and is replaced by anæsthesia of the centre." This interesting phenomenon leads Morrow to the hypothesis "that in the evolution of these macules, hyperchromia and hyperæsthesia, achromia and anæsthesia, are associated and advance *pari passu.*" Sometimes, however, instead of following the mode of development just described, the pigmentary changes are achromic or hyperchromic from the beginning.

Besides the neurotic anomalies just considered, we may also encounter both sensory and motor disturbances of much greater extent. Thus, very large areas of the skin may be the seat of analgesia and insensibility to temperature as well as atrophic changes; while, at the same time, the further extension of the neuritic changes to important motor nerves may cause more or less extensive paralysis and atrophy of the muscles. To

these changes in the skin and muscles various lesions of the bones and joints are added, and these are apt to culminate sooner or later in more or less extensive mutilations. The macular spots previously described are not the only dermal changes in leprosy; for, in addition, pemphigoid lesions of a severe type are common enough. Sometimes, however, all, or nearly all, of these dermal appearances are absent; and in such anomalous cases the sensory or motor impairment may be the chief or even the sole feature. Under these circumstances a correct diagnosis is, as a matter of course, most difficult.

Lastly, the nerves most frequently involved are the nervus cutaneus palmaris, in which the neuritic changes commonly begin, when the upper extremity is affected, and the nervus peroneus and nervus cutaneus femoris posterior externus, which are first impaired when the disease begins in the legs. In addition to these changes in the cutaneous nerves, the large deep-seated nerves also undergo degeneration; hence the extensive paralyses and atrophy of the muscles. However, even when the disease has lasted a long time, all the nerves are by no means equally affected. Thus, the third or seventh pair of cranial nerves may be predominantly involved, and we then have derange-

ment of the motor apparatus of the eye, or paralysis of the muscles of the face, with the characteristic distortion of the mouth. Again, the neuritis may evince a predilection for the nerves of the arm, and notably the ulnar nerve, and we then have atrophic changes in the muscles of the hand and arm quite like those which constitute the *main en griffe* of progressive muscular atrophy. The presence of profound anæsthesia will, however, serve to differentiate the condition from the last-named affection.

Mention has already been made of the great difficulties which sometimes beset the differential diagnosis of leprosy from syringomyelia. A reference to the symptomatology of the last-named affection will serve to show why this should be so. In the face of such obstacles it would probably be rather premature to lay down arbitrary rules governing the differentiation of the two affections, especially when the leprosy is at all atypical.

For many details of the preceding description and for valuable information regarding the whole subject of leprosy, I desire to express my indebtedness to Dr. Morrow, whose practical knowledge of the disease gained by prolonged study in the Sandwich Islands is unsurpassed.

Beriberi.—Scheube was the first to show that the

remarkable disease variously known as "beriberi" and "kakke," which occurs in the East Indies and Japan, is nothing more nor less than a form of multiple neuritis. Since the publication of Scheube's paper it has furthermore been shown that this neuritis is directly due to the presence in the system of a peculiar micro-organism. These and micrococci bacilli may be detected in the blood of persons suffering from beriberi; and, what is still more conclusive, pure cultures of the micrococci cause, when injected into dogs and rabbits, changes in the nerves similar to those found in beriberi.

It is probable that the infecting substance usually gains access to the body through the respiratory apparatus, although infection through the clothing is not uncommon. On the other hand, some observers, among whom is Nimra, believe that introduction of putrid fish of the genus Scomiridæ is the principal, if not the sole, cause of the disease. The bulk of evidence, however, goes to show that beriberi is an infectious disease, principally transmissible through the air and clothing.

Symptoms of Beriberi.—It is not an altogether easy task to give a general description of beriberi, since the disease presents itself under a multitude of guises; still, a certain number of more or less

well-marked forms are discernible. These are, however, closely united clinically by various transitional phases, while in a pathological sense they are, of course, identical.

All forms of the disease present a more or less marked initial stage. The patient is conscious of being unwell; he is listless, feverish, and easily tired by walking; his conjunctivæ are injected and more or less acutely inflamed; he has some watery discharge from the nose; and he suffers from weakness and a general sense of bodily discomfort. These premonitory symptoms are soon followed by tingling, numbness, and more or less pain in the lower limbs, as well as pronounced motor impairment and œdema. A most important symptom at this time is weakness and rapidity of the heart's action; and to its presence is doubtless to be ascribed the œdematous condition of the legs and arms previously referred to.

In addition to the sensory impairment, there is marked paresis and absence of the tendon reflexes. Ataxia as we find it in alcoholic cases is, however, absent. The future course of the disease is either favorable or unfavorable. When favorable, recovery takes place in ten days or six weeks, or exceptionally, in chronic cases, in from sixty to ninety days; when unfavorable, various other grave symptoms are

added, and the patient either dies or recovers, but only after a long illness.

Let us consider the symptoms which are peculiar to the less favorable cases. In the first place, the œdema previously alluded to as a feature of the mild cases may assume unusual proportions, so that effusion takes place into the pleural and peritoneal cavities, as well as into the subcutaneous tissue. The entire body of a person afflicted in this way is enormously swollen, the action of the heart is greatly reduced in vigor, paralysis more or less extensive is always present, and the affected muscles atrophy precisely as in other forms of neuritis. This wasting of the muscles is not visible to the eye on account of the œdema, but it may often be ascertained by careful palpation. This is the so-called hydropic form of the disease. Again, there may be little or no œdema; but, as if to compensate for its absence, the sensory and motor disturbances are more extensive and severe.

The muscles of the entire body atrophy; sensibility is so exalted that the patient can hardly endure the weight of the bedclothes; he suffers more or less acute pain; and his general appearance is that of an individual in the last stages of phthisis. In some cases the hyperæsthesia is succeeded by a certain degree of anæsthesia, and there may be

delay in the transmission of painful sensations, as in ataxia; but, as a rule, variations in temperature are perceived even when the disease is at its height. This is the dry or atrophic form of the disease. Finally, the symptoms of the hydropic and atrophic types may be combined. Cases of this kind pursue an acute course, and death usually takes place from heart-failure. In both the hydropic and atrophic phases of the disease recovery takes place in a large proportion of cases, but only after a long period of convalescence. In the fatal cases death results from some intercurrent affection or from exhaustion.

Diagnosis.—From what has already been learned, it is evident that the diagnosis of the disease may present certain difficulties. Two affections in particular—locomotor ataxia and poliomyelitis—have often been mistaken for it. For purposes of differentiation, the sensory symptoms occurring in the beginning of most cases of multiple neuritis are of the first importance. Especially may this be said of the extreme sensitiveness of the nerves and muscles to pressure,—a condition which is foreign to both ataxia and poliomyelitis. In ataxia, moreover, the characteristic incoördination of the muscles is developed slowly, there is no true paralysis of the muscles nor atrophy, and the pupillary reactions are interfered with (Argyll-Robertson pupil).

In multiple neuritis, on the other hand, the loss of power is rapid, the affected muscles atrophy, and there are no abnormal changes in the pupil.

Prognosis.—From what has previously been said, it is evident that the prognosis is fair in many phases of multiple neuritis. It is, of course, positively unfavorable in those cases of neuritis which develop in the course of leprosy, beriberi, tubercular disease, and less so in alcoholism. In expressing an opinion as to the probable outcome in a given case great caution should, however, be exercised, as both the laboratory and clinic have repeatedly shown how great is the power of regeneration possessed by the peripheral nerves as contrasted with other portions of the nervous system, and notably the spinal cord.

The anatomical changes in the acute cases are essentially inflammatory, while in those which pursue a chronic course they are of the nature of a degenerative atrophy. Moreover, the ramifications of the nerves are more profoundly affected than the stems.

As the minute pathological changes have already been discussed under the head of simple neuritis, nothing further need be said of them.

CHAPTER III.

CONCERNING PAINS LOCATED IN DEFINITE NERVE-AREAS—NEURALGIA.

From what has previously been said, it is evident that every painful impression must be due to an irritation of one or several nerves, and it has also been shown that the usual source of such morbidly increased stimulation is neuritis. Inflammation of the nerves cannot, however, be regarded as the only cause of pain, as some authors would have us believe. There are, indeed, certain fugitive pains whose advent and subsidence are so sudden as to preclude the development of true inflammation. In my opinion, such pains are usually attributable either to a molecular or circulatory disturbance in the nerve, due to an external agent, such as cold, or they are traceable to a toxic agent temporarily contained in the blood. Some of the painful nervous disturbances consecutive to influenza are apparently of this character, though others, as Gowers has recently pointed out, are traceable to neuritis. Whatever may be the opinion held, then, regarding

evanescent pains, it must be assumed that where the morbid sensation is both localized and persistent, as in neuralgia, we have indeed to do with a veritable inflammation of the nerve. Hence it follows that the causation of these local pains or neuralgias is substantially that of neuritis.

From the foregoing, it is evident that what is currently known as neuralgia may be defined as an affection of the nerves, characterized by the occurrence of sudden, severe paroxysms of pain in regions supplied by one or several nerves.

For purposes of exact designation these pains have been classified according to the nerve-stem or branch chiefly implicated.

All these forms of neuralgia have certain common attributes, the variations in symptomatology being contingent, or largely contingent, upon differences of locality. It is apparent, therefore, that some preliminary observations of a general character will save much needless repetition.

The onset of the affection is usually heralded by vague muscular twitchings or sensations of pricking, quickly succeeded by darting pains. The pains are recurrent in character, following each other with ever-increasing frequency and intensity, until, in the more severe attacks, the patient suffers the most excruciating agony. In some cases the pains are

darting or lancinating, whereas in others they are compared with the prick of red-hot needles.

The pains, as previously observed, are usually localized, and the subject declares that, however long may be the intermission between the paroxysms, the pains always return to the same locality. Such is apt to be the case where the neuritis is restricted to a single nerve or one or more of its principal branches.

Sometimes, however, the neuritis is much more widely distributed, and, as a consequence, the pains dart about from place to place, first one part of the affected region being assailed and then another.

When subjected to pressure the nerve is found to be extremely tender, the hyperæsthesia being either circumscribed, so as to constitute the so-called "*points douloureux*," or more widely distributed, giving rise to irregular areas of great tenderness in the skin.

Should careful exploration with the finger fail to disclose these painful spots, the passage of the faradic current through the suspected locality, either by the aid of a small sponge electrode or the wire brush, will at once reveal their presence.

Another noteworthy circumstance is, that when, in the course of an attack of severe neuralgia,—especially that of an intercostal or lumbar type,—pressure is applied along the spine, painful areas

corresponding to the origin of the affected nerves are frequently found.

But pain is not the only sensory disturbance met with in neuralgia, since formication, numbness, and even anæsthesia are quite common.

Where the anæsthesia is well marked and extensive, it is evidence that the inflammatory changes in the nerve are severe enough to interrupt conduction, a fact which has an obvious bearing on the prognosis. On the other hand, the irritative phenomena may be of such a violent character as to completely overshadow all other elements in the case. Under these circumstances reflex muscular spasms are apt to develop; so that, in neuralgia of the trigeminal nerve, the facial muscles may be sufficiently convulsed to cause grotesque distortion of the countenance; while, in the same way, the presence of neuralgia in one of the limbs may give rise to muscular contractions which may be restricted in character or involve the entire limb.

These spasms are so clearly of reflex origin that the mode of their genesis is hardly to be regarded as an open question.

Persons of weak constitution, or those in whom debility, resulting from disease or excesses, has materially curtailed the powers of resistance originally inherent in the organism, are especially exposed

to neuralgia. This is equivalent to stating that they inevitably invite an attack of neuritis, since they are susceptible alike to cold and septic influences of all kinds.

The following are the more important manifestations of the affection in different localities:

In trigeminal or facial neuralgia the pain may involve the entire lateral half of the face and head when all three branches of the nerve are involved, but is much restricted when but one branch is implicated. Thus, when the neuritic condition is confined to the supraorbital or ophthalmic branch, the pain is felt in the forehead and upper eyelid, and is accompanied by more or less lachrymation. In neuralgia of the supramaxillary branch the pains are located in the eyelid, cheek, nose, upper lip, nasal cavities, gums, upper teeth, zygomatic arch, and temporal region; whereas implication of the entire inframaxillary branch gives rise to pain in the lower teeth and jaw, the mucous membrane of the mouth, the tongue, the chin, the cheek, and the external auditory meatus and auricle.

The vaso-motor disturbances of facial neuralgia consist in coldness and pallor, which may later give place to an œdematous and glossy skin. Allusion has already been made to the reflex muscular spasms which sometimes accompany the severer

types of the disease, so that nothing further need be said regarding these interesting appearances.

Severe mental depression, irritability, and insomnia are common accompaniments of facial neuralgia; and when the paroxysms become chronic, there is a progressive physical and mental deterioration, which may drive the unhappy sufferer to seek relief in self-destruction. In a subsequent chapter I shall indicate the most effective measures to be adopted in dealing with these distressing complications of pain.

In cervico-occipital neuralgia, the region supplied by the great occipital nerve is the principal seat of pain; but exceptionally it may be reflected to the neck and lower part of the face.

The pains of cervico-brachial neuralgia are felt in the subclavian region and throughout the upper extremity. Should, however, the plexus be only partially invaded, the pain is, of course, much less widely distributed. Where these conditions prevail it may be difficult to determine what branches of the plexus or nerve-roots are predominantly involved.

In crural neuralgia the pains are chiefly felt along the anterior and inner aspects of the thigh.

When the first pairs of the lumbar nerves are involved the pain is restricted to the loins; whereas

in lumbo-abdominal neuralgia it extends to the hypogastrium, and may also include the scrotum or mons veneris.

The back and the walls of the thorax are the seat of pain in dorso-intercostal neuralgia; but it often happens that it is more acutely felt in the former, and is then commonly referred to as lumbago.

In sciatic neuralgia the pain extends from the gluteal region down the posterior aspect of the thigh and leg; and at the point of emergence of the nerve from the plexus a spot of unusual tenderness is usually present. Plantar neuralgia, which was first accurately described by Dr. Weir Mitchell, is characterized by severe pain in the sole of the foot. Both feet are usually affected, and there is more or less redness and swelling.

The designation coccygodynia has been applied to those severe pains in the coccyx due to difficult labor, injuries, inflammation, caries, and other causes which may give rise to secondary inflammatory changes in the coccygeal plexus. Extirpation of the coccyx is really the only effectual treatment.

Mastodynia, or "irritable breast," as it is often called, is nothing more than a variety of intercostal neuralgia, and is amenable to the same treatment as other forms of localized pain.

Muscular neuralgia is the conventional term em-

ployed to designate a painful condition of the muscles, which may exist in the absence of all tenderness of adjacent nerve-stems.

The muscles of the back and neck are those most frequently implicated.

Let me add, in concluding this brief survey of the more important features of neuralgia, that the prognosis is substantially that of neuritis, as stated in the preceding chapter. Where the neuritic changes are of recent occurrence, permanent relief may generally be afforded without much difficulty; but when they are of long standing, the outlook, though far from hopeless, is less favorable. The whole question of treatment will, however, be thoroughly discussed in the chapter devoted to the therapeutics of pain.

CHAPTER IV.

PAIN ASSOCIATED WITH THE RHEUMATIC AND GOUTY DIATHESIS.

Though the ultimate pathology of both these affections is, in spite of a vast amount of research and discussion, still in an unsatisfactory condition, it will, nevertheless, be advisable to consider them briefly: first, because they are such prolific sources of pain, and, secondly, because of the tendency, at present discernible in some quarters, to ascribe importance to a neuropathic principle as an element in their development.

Rheumatic fever, as is plainly enough indicated by its clinical history, is an acute febrile affection of non-contagious character, the most evident characteristics of which are the development of multiple arthritis and a disposition to invade the heart.

There are three conspicuous theories with regard to the nature of the affection. The first of these affirms that the changes in the joints are due to the presence of a specific microbe; the second, that they are the outgrowth of defective metabolism,—*i.e.*, the

presence of pathological material in the system, due to derangement of assimilation; and the third, that the arthritis is attributable to a primary disturbance of the nervous system, culminating either in impairment of metabolism or in local trophic changes which are the result of the primary effects of cold upon the nervous system.

It is noteworthy that by some the morbid product due to this defective metabolism is believed to be lactic acid.

In gout, as all are aware, we have to do with a disease which is characterized by the appearance at irregular intervals of acute arthritis, with subsequent gradual deposit of urate of soda within and in the vicinity of the joints, and by the over-production, or defective elimination, of uric acid.

Concerning the causation of gout, three theories are likewise worthy of mention.

The first of these—the so-called uric acid theory—has obtained the widest currency in the profession. According to its tenets, there is an increased accumulation of uric acid in the blood, attributable either to inadequate elimination or over-production.

The advent of the acute attack is believed to be directly attributable to this morbid accumulation, and the same may be said of the nervous irritability, depression, and gastric derangements which are the

common precursors of the acute inflammation of the joints.

A second theory is that of Ord, who believes that the changes in the joints are directly due to a degenerative proclivity of the tissues themselves. This liability to degenerate may be either congenital or acquired. I do not think that there is much justification for this assumption, since dietetic precautions usually prevent the local degeneration.

Finally, we have the nervous, or rather neurohumoral, theory of the disease as advocated by Duckworth and others. This theory assumes, on the one hand, the existence of a neurosis, and on the other, a tendency to lethargic or defective metamorphosis.

So much, then, for the diversity of opinion which exists regarding the ultimate pathology of the two affections. But while these differences are striking enough in themselves to discourage one from attempting to elaborate a scientific method of treating the disease, it must nevertheless be admitted that quite a good deal has been accomplished within the last few years—largely in an empirical way—for the more effective management of both disorders. This may be said with especial emphasis of the painful symptoms which are so striking a feature of both diseases.

It is hardly necessary to enter upon a lengthy description of the regular forms of gout and rheumatism: the metatarso-phalangeal pain and redness, confined, as a rule, to one of the great toes, the premonitory gastric symptoms, the sudden onset of the pain,—usually at night,—and the moderate chilliness and fever, are quite characteristic of the former; whereas the presence of acute inflammation and pain in several joints is decided evidence of the rheumatic nature of the trouble.

But while these typical manifestations of both diseases are known to every physician, the irregular modes of expression have commonly received, I believe, much less attention than they deserve. These observations are especially applicable to "concealed" or "irregular" gout, which is certainly often responsible for the development of nervous symptoms, and notably neuralgia. Again, the chronic interstitial nephritis which frequently develops in severe cases of gout is responsible, no doubt, for the advent of some of the milder forms of nervous disturbance. Eventually, as in ordinary cases of contracted kidney, death may occur from cerebral hemorrhage (or embolism, where there is concurrent heart-trouble) or uræmia. One of the most frequent cerebral manifestations, commonly—and probably justly—ascribed to the morbid accu-

mulation of uric acid, is headache; which, though usually of the less vehement type, may exceptionally manifest great severity.

With the occurrence of renal troubles and arteriosclerosis, the cerebral disturbances may be much increased in severity and persistency. It is self-evident that symptoms of this kind may readily be misinterpreted where the question of causation is involved; so that nothing is more common than to find these patients wandering about from one medical practitioner to another, without obtaining any considerable benefit. The chief difficulty in such cases is usually a failure on the part of the physician to appreciate the true chronology of the various symptoms.

Too great pains, then, cannot be bestowed upon the framing of a correct diagnosis, without which there is scant probability of our suggesting therapeutic measures of much utility.

Treatment.—Little need be said of the management of the acute phases of rheumatism, since every practitioner is doubtless familiar with essentials. As all are aware, two methods of treatment are especially conspicuous; the one involving the copious use of salicylic acid, the other the administration of alkalies. The use of salicylic acid is especially satisfactory, since the pains yield to its

influence with remarkable promptness. On the other hand, alkalies are more liable to prevent the occurrence of secondary heart-trouble; and besides this, it is a remarkable fact that patients who have been treated with them are usually able to leave the hospital and attend to their affairs much sooner than those who have taken salicylic acid alone. It is evident, then, that each plan of treatment has its own special advantages; and for this reason I prefer the mixed treatment, or that which involves the use of both acid and alkalies.

The salicylate of sodium may be used in twenty-grain doses every hour for the first six or seven hours. The patient may then be instructed to discontinue all medicine for the next eight hours. After the lapse of this interval of rest he may be given the iodide or citrate of potash in twenty- or thirty-grain doses every three hours, until the saliva becomes alkaline. Whether, as stated by some, this recommendation originated with Fenwick, I do not know; but I can certainly vouch for its efficacy, especially when combined with the use of phenacetin and salol. The local application of the oil of wintergreen by the aid of lamb's wool or absorbent cotton will naturally suggest itself, and the same may be said of the use of liniments, blisters, and sinapisms.

When recovery has taken place, great caution should be exercised in the use of stimulants; and indeed, all foods the ingestion of which is liable to add to the acidity of the blood should be avoided as much as possible. This is all the more necessary since those who have had one visitation, far from having obtained immunity, are more than ever liable to be attacked by the disease.

Very much the same class of recommendations are applicable in the management of gout, whether of the common, acute type or of the concealed variety.

When the great toe is very painful, the entire limb should be elevated and the painful joint wrapped in wool or treated with hot applications. Should the pain refuse to yield to local measures of any kind, it may be necessary to invoke the aid of analgesis; and, if the patient be of a nervous, irritable disposition, the best way out of the difficulty will be to give him a moderate dose of morphine.

Colchicum in twenty- or thirty-minim doses, either of the tincture or wine, may be given every four hours; for, though much less used at present than before the introduction of salicylic acid, this remedy exerts an undoubted influence in reducing the redness and abating the pain in the joint.

Mineral waters of various kinds have been found useful in gout. Among those commonly recommended are the waters of Vichy, Carlsbad, Saratoga, and White Sulphur Springs.

When the disease becomes chronic, warm baths—and notably those of Wiesbaden, Teplitz, Carlsbad, Aix, and Ems—may be prescribed with advantage.

It has become fashionable of late to prescribe a special diet for those afflicted with gout; and, though nominally founded on the theoretic exigencies of the disease, a glance will reveal discrepancies of opinion which it is hard to reconcile by even the most adroit sophistry. The chief desideratum, after all, is to reduce the quantity of food ingested,—a precaution which of itself cannot fail to diminish the dangers of defective metabolism and consequent accumulation of uric acid. As may readily be inferred, both the acid and saccharine foods are to be excluded as far as possible; and, without burdening the mind of the patient too much with details, he should be informed at once that the success of treatment is largely a question of his own volitional ability.

In concluding these brief observations on the management of rheumatism and gout, it will be well to consider a remedy which has been much written about of late in connection with its reputed

quality as a solvent of uric acid. I allude, of course, to piperazin ($C_4H_{10}N_2$). The routine quantity of fifteen grains *pro die* in divided doses is applicable in the cases characterized by moderate uric acid accumulations, whereas in severe and obstinate rheumatism this amount may be much exceeded. The remedy is quite soluble in water, and forms an alkaline but non-caustic solution. Its power of dissolving uric acid has been shown, by the researches of Schmidt and Biesenthal, to be much greater than that of sodium carbonate, lithium carbonate, or borax solution. In dissolving uric acid, piperazin combines with this body, forming urate of piperazin, which in turn is exceedingly soluble in water. This piperazin urate is, moreover, much more readily diffusible through animal membranes than the lithium and sodium urates. All this is equivalent to stating that a piperazin solution is able to penetrate to the most remote tissues, dissolve the uric acid which may be deposited there, and finally escape in the form of urate of piperazin by way of the kidney. Piperazin is best given in solution in order to insure rapid absorption. It may also be exhibited with great effect, in cases accompanied by much pain, in combination with an equal dose of phenocoll, the analgesic properties of which are well known. To carry out this idea in a practical way,

a phenocoll-piperazin water has been prepared, each pint of which contains eight grains of phenocoll and eight grains of piperazin. Two or three pints of this water may be drunk daily without the least unpleasant consequences.

Space will not permit a more extended discussion of details, which properly belong in special monographs and treatises on general medicine. One of the most recent and practical of the former is Dr. Satterlee's little book, which will be found to abound in helpful suggestions.

CHAPTER V.

PAINS WHICH HAVE THEIR SEAT IN THE STRUCTURES CONTAINED WITHIN THE CAVITIES OF THE BODY—INTRACRANIAL PAINS (HEADACHE)—"SPINAL" (MEDULLARY) PAINS—ABDOMINAL AND THORACIC (VISCERAL) PAINS.

THE pains associated with inflammatory changes in the nerves which supply the exterior of the body having been previously considered, it now remains to examine in a general way those pains that have their seat in the structures contained in the various cavities of the body. Prominent among such pains are what are currently known as headaches, all or most of which—if we except those due to syphilitic periostitis of the cranium and disease of the internal ear—are attributable to *intracranial causes.*

These pains which are directly or indirectly referrible to disturbances within the cranial cavity are characterized by the presence of more or less mental irritability, prostration, and sensory hyperæsthesia, and less frequently by vertigo, nausea, and vomiting.

Various attempts to classify these intracranial pains have been made; but as our knowledge of

their causation is still incomplete, all such efforts are necessarily imperfect.

The following nomenclature, which is a slight modification of that adopted in my book on "Headache and Neuralgia," is perhaps open to as little criticism as any.

Pains which have their Seat within the Cranial Cavity—Intracranial Pains—Headache.—Anæmic headache, as its name implies, is proximately due to a deficiency of the blood-supply within the cranial cavity. It is an almost invariable accompaniment of general anæmia and chlorosis, and hence young persons, and more especially girls, are particularly subject to its attacks. Any morbid condition which culminates in a reduction of the normal amount of blood in the system may cause it. Hence it may be associated with widely-different diseases. Debility, then, is the great prerequisite to its occurrence.

The more important symptoms of this anæmic form of headache are clawing pains at the vertex, vertigo evoked by suddenly changing from an erect to a recumbent position, increased compressibility of the carotids, facial pallor, fatigue upon slight exertion, mental depression, hyperæsthesia of the special senses, particularly sight and hearing, drooping of the eyelids, drowsiness during the day and

sleeplessness at night, and finally, pronounced cardiac weakness.

Hyperæmic headache, the opposite condition of that previously described, is due to an increase in the arterial blood-tension with accompanying relaxation of the cerebral capillaries. Its characteristic symptoms are sensations of fulness in the head; vertiginous attacks appearing spontaneously or following changes of position; morbid irritability, as exemplified by sudden anger upon trivial provocation; throbbing of the carotids; and attacks of palpitation.

Nervous or cerebral headache is sometimes hemicranial in type, but more frequently there is little that is distinctive about it either in quality or location. Sometimes the pain is predominantly felt in the forehead, vertex, or occiput; whereas, in a smaller percentage of cases, it evinces a predilection for the temple, or, as already mentioned, for one-half of the head.

Whatever the precise location of the pain may be, however, there is always more or less mental irritability, and usually also nausea and vertigo. Visual and auditory hyperæsthesia are likewise characteristic and quite constant accompaniments.

The cerebro-hyperæmic and cerebro-anæmic forms of headache represent merely modifications of the

nervous type of head-pains, the alterations in the clinical picture being due, or largely due, to the presence of a marked degree of circulatory disturbance.

The neurasthenic type of headache is usually much like that just described as "nervous" headache. There are, however, occasional deviations in type,—deviations which vividly recall the symptoms more particularly described under the head of anæmic headache. Then, too, there are also present in varying degrees of intensity the well-marked phenomena of nervous exhaustion,—the so-called neurasthenic symptoms; and these, taken in conjunction with the general history of the case, will serve to facilitate diagnosis.

The lymphatic or bilious headaches include the various head-pains which are obviously due to some peripheral source of irritation,—to some cause originating outside the cerebro-spinal canal. While hemorrhoids, ovarian disease, and uterine derangements may give rise to it, its most prolific cause must be sought for among the manifold disturbances of the organs of digestion.

It is highly probable, however, that, inasmuch as these disorders may exist in the absence of all head-symptoms, a certain neurotic predisposition is essential, in order that the peripheral disturbances

shall culminate in intracranial derangements of a painful character. In consonance with this opinion, we find that impressionable young people, and more especially girls, are subject to this form of headache.

The symptomatology presents nothing of especial interest, and its principal features are soon told. There are local pains of a constant, heavy, clawing character; yellow appearance of the skin; stomachic discomfort; general malaise and depression; and not infrequently attacks of giddiness, which are erroneously ascribed by the subject to cerebral causes, but which primarily, at least, are due to irritation emanating from the stomach.

In the toxic form of head-pain we have—in so far as the causation is discoverable—to do with some change in the normal constitution of the blood, due either to the evolution of some toxic condition within the organism itself, or to the introduction of some poisonous agent from without. Uræmia affords an excellent example of the one, and chronic alcoholism of the other, mode of poisoning. Let the method of poisoning be what it may, its results, a toxic condition of the blood and consequent irritation of the nervous system, are the same.

The pains have nothing especially characteristic about them, when considered collectively. Sometimes they may be dull and heavy, as we find them

among brass-workers, or they may be splitting, as in the headache of syphilis.

In all cases permanent relief is contingent upon removal of the poison from the system. This is not possible where the source of the poison is found in some organic alteration of the viscera, as in Bright's disease. It is, however, more readily attainable when the toxic agent has been introduced from without, as in syphilis and lead-poisoning. These are, however, matters which will be treated more in detail in the chapter especially devoted to the treatment of pain.

The lesions which are largely responsible for organic head-pain are syphilis and the various kinds of tumors, disease of the cerebral arteries, tuberculosis, cerebral softening, bony formations within the cranial vault, and meningitis. Organic disease is, however, by no means as frequent a cause of headache as might be imagined from the percentage of gross cerebral lesions. Nor is the diagnosis of this variety of headache always an easy matter; for, in the first place, there may be nothing especially characteristic about the pain; and, secondly, more or less profound organic changes may be present without evoking painful manifestations of any kind.

Speaking in a general way, it may be said that

headaches due to organic disease of the brain are usually more or less continuous in character, and are referred to a circumscribed portion of the cranium. Concomitant disturbances of sensation and motion, assuming the form either of local spasms, paresis, or impairment of vision, or combinations of all of them, may help to clarify the diagnosis; but these are by no means always present. Sometimes the loss of muscular power is very gradually accomplished; and under these circumstances vertigo, impairment of memory, and loss of visual efficiency (optic neuritis) assume a prominent place in the symptomatology.

Headache accompanied by epileptic phenomena, facial paralysis, and disturbances of speech, occurring at the period of adolescence, may, in the absence of negative testimony, be ascribed to syphilis. In such cases copious mercurial inunctions and the administration of large doses of the iodides are sometimes followed by a reduction and eventual disappearance of the symptoms.

Unfortunately, such a happy issue is rather the exception than the rule, and is only to be anticipated in cases with undoubted syphilitic antecedents. In the vast majority of cases of organic headache we are indeed quite unable to extricate the patient from his deplorable plight. Occasionally, it is true,

cerebral surgery has been able to accomplish something; but this field of the art is necessarily limited: first, by the imperfections of diagnosis; secondly, by the fact that a large proportion of cerebral growths are malignant; and, thirdly, because extensive intracranial extirpations mean a commensurate obliteration of important cerebral organs. No amount of sophistry can modify the situation in this regard one whit.

In a large proportion of cases, then, treatment is purely palliative, and consists for the most part in the amelioration of the pains by opiates.

Pains which have their Seat within the Thoracic Cavity.—The majority of pains located within the thoracic cavity are due either to the presence of neoplasms or aneurism, or they occur in the course of acute affections of the heart or lungs. The more detailed consideration of these pains belongs without doubt in the domain of general medicine. There is, however, one variety of præcordial pain which may properly be considered in a work of this kind; I refer to the affection variously known in the books as *angina pectoris*, *stenocardia*, *nervous heart-pain*, *or cardiac neuralgia*. Now, it is a well-known anatomical fact that the superior and inferior cardiac branches of the vagus join the cardiac branches of the sympathetic to form the cardiac

plexus. In accordance with current physiological opinion, three kinds of fibres are assumed to exist in this plexus: those whose stimulation accelerates the heart-beat; those whose stimulation retards the heart-beat; and, finally, those whose function is the conveyance of sensory impressions from the heart.

Inasmuch as pain is the cardinal symptom of angina pectoris, the affection in its idiopathic form is commonly regarded—and it must be confessed with considerable reason—as a neurosis of the pneumogastric nerve. Some participation of the sympathetic system of nerves is also probable, as Lancereaux and others have been able to show from the results of a number of autopsies.

A sharp differentiation of this, the true or idiopathic form of the affection, as contrasted with the angina-like pains due to organic disease of the heart, must of course be maintained. Among the cardiac lesions which most frequently give rise to pseudo-angina, if I may so call it, are valvular disease, fatty degeneration of the muscle, and disease of the coronary arteries.

The clinical phenomena of angina pectoris have been described in the text-books over and over again during the last century, so that all practitioners are doubtless well able to recognize the affection. The

most obvious symptoms are a severe pain occurring in paroxysms in the neighborhood of the left nipple, a feeling of impending dissolution, profuse cold perspiration, and occasional dyspnœa.

As a rule, there is no aura whatever, the seizure taking place without warning by day or night, regardless of all ascertainable physical or psychical incentive. Where there is absence of organic changes in the heart, there is complete cessation of all symptoms during the intervals, the patient declaring at such times that he feels as well as ever. Under these circumstances, when we have apparently to do with a neurosis of the sensory filaments of the heart ("vagus neurosis"), the danger to life is practically *nil.* When, however, atheroma of the coronary arteries or some other grave cardiac lesion is present, the outlook is threatening, death during a paroxysm being a frequent sequence.

The really efficacious remedies at our command for combating the paroxysm are few in number and well known to the profession. The inhalation of from four to eight drops of the nitrite of amyl is generally regarded with favor; and those who are the victims of inveterate angina should be told to carry about a few of the well-known hollow glass beads, each of which contains a medium dose of the drug. One or more of these may be broken

upon a handkerchief and inhaled as soon after the inception of the attack as possible.

Hypodermic injections of morphine and inhalations of chloroform or ether have, in my experience, often rendered good service. All kinds of remedies have been exhibited during the intervals with a view to aborting the attacks and eventually obtaining exemption from the difficulty. It must be confessed, however, that the results thus far accomplished are not brilliant. Digitalis, spartein, strophanthus, and indeed the whole group of cardiac stimulants have been tried, and the same may be said of the so-called alteratives. Nothing, however, save disappointment has come of all this.

Speaking generally, it may be said that the factors which are likely to engender a predisposition to neuritis are those which are most carefully to be avoided. Among these tobacco has been assigned —and rightly so, it would seem—a prominent position. And yet many cases of idiopathic angina occur among women,—cases in which a subsequent autopsy has failed to reveal any organic disease which might reasonably be supposed to account for the symptoms, and in which, moreover, the entire clinical history may be absolutely negative in so far as it affords a clue to questions of causation.

The whole matter of etiology, then, in so far as

so-called functional or idiopathic cases are concerned, is enveloped in more or less obscurity.

Pains which have their Seat in the Cavities of the Abdomen and Pelvis.—To enumerate and discuss even a small number of the pains which are intimately associated with the development of acute diseases or neoplasms would overtax the limits of the present publication. Indeed, the more detailed consideration of such pains is in the nature of things intimately connected with that of the diseases themselves, of which the pains are but one of the modes of expression; hence the whole subject belongs in the domain of general medicine, and there I shall leave it.

Let me add, however, that in a subsequent portion of this work I shall offer a few observations on the practical management of pain the source of which is located in one of the large cavities of the body, and is therefore inaccessible to local means of attack.

CHAPTER VI.

THE DIAGNOSTIC VALUE OF PAIN.

It has already been shown that the peripheral (sensory) nerves afford the only routes by which painful impressions are transmitted to the cerebro-spinal axis, and thence to the centres of conscious perception. Moreover, it is equally clear that the greater the supply of such filaments to a part, the greater must necessarily be the susceptibility of that region to pain-provoking influences. Herein lies the explanation of the striking variations in the intensity of painful sensations emanating from the different tissues.

Every physician is cognizant of this immense diversity of sensibility as a matter of practical experience, but few pause to consider the simple anatomical fact which lies at the basis of the phenomenon. The sensibility of bone (even if we include the periosteum) is not equal to that of the skin; nor is that of cartilage comparable with that of the muscle.

The varying degrees to which the sensory nervous

system has been developed in these tissues are sufficient, then, to account for quantitative differences in the pains.

But variations in the abundance of the sensory nerve-supply, while certainly the main factor in determining the differences in pain-susceptibility of the tissues, do not give rise to qualitative modifications.

These differences in the kinds of pain which we feel are far more likely to be contingent upon the nature of the pathological process prevailing in the tissue. At all events, this seems to hold good with regard to the nerves of common sensation.

Another important fact is, that the mind usually refers the painful sensations perceived by it to the seat of irritation (disease). The exceptions to this rule will be considered later. Thus it happens that one of the greatest services, if not the very greatest, which pain renders the clinician consists in its ability to point out the seat of trouble. The result of this is that, even when the pain itself is not sufficiently characteristic to admit of our deriving from it exact inferences as to the nature of the disease, our attention is, nevertheless, at once drawn to the seat of trouble; investigation reveals a number of collateral symptoms; and these, in conjunction

with the pain, enable us to form an exact diagnosis.

Regarded from this stand-point alone, it is almost impossible to over-estimate the diagnostic value of pain. The wonder is that so little attention has been accorded it in current works on diagnosis.

In view of the importance of the subject on the one hand, and the paucity of helpful literature on the other, I trust that by citing some of the more important examples of the helpfulness of pain in diagnosis I shall not trespass unduly upon the patience of the reader.

Pains about the Head, including the Eye and Ear.—In the headache of anæmia there is present quite a characteristic kind of pain,—the clawing sensation at the vertex, with concomitant vertigo and drowsiness, and morbid susceptibility to light and sound. In the opposite condition of cerebral engorgement the pain is more diffuse, and is accompanied by a feeling of fulness and constriction.

Severe unilateral pain, with photophobia and gastric derangements, constitute the more striking features of megrim.

Pain over the orbit is also quite characteristic of the headache due to malarial poisoning ("brow ague," supraorbital neuralgia). Of this type of

headache we have already had something to say when discussing the various forms of neuralgia,—that phase of pain in which the symptoms are practically restricted to the ramifications of one or more nerve-stems.

Syphilis, too, frequently gives rise to a very characteristic kind of head-pain,—the well-known "splitting, boring" headache.

Again, in the severe headaches due to tumors and other organic lesions located within the cranium, the pain is apt to be constant and more or less confined to definite regions of the cranium.

This reference of the pain by the patient to certain areas cannot, however, be regarded as positive proof of the correct localization of the central lesion; for it has frequently happened that a subsequent post-mortem examination has shown the conceptions of the subject to have been entirely at fault, the lesion being found in quite a different portion of the intracranial structures. In addition to the severe pain, organic headache is frequently accompanied by more or less profound derangements of sensation and motion. These disturbances usually assume the form of spasms, paresis, and visual impairment (optic neuritis, paralysis of extrinsic ocular muscles, etc.).

Again, vertigo, derangements of memory, and

progressive loss of muscular power are the concomitant factors in other cases.

Some of the pains found in and about the eye are of the highest importance from a diagnostic stand-point, since, in conjunction with other symptoms, they enable us to detect the presence of severe disease of the eyeball in time to act effectively against it.

This is especially true of acute glaucoma, panophthalmitis, and plastic iritis.

In acute glaucoma there is present severe pain in the eyeball, with concomitant dilatation of the pupil, shallow anterior chamber, increased tension of the eyeball, impairment of vision, photophobia, redness of the eye, and lachrymation. The pain is hemicranial in type, and may involve not only the area supplied by the supraorbital nerve, but also that to which other branches of the fifth nerve are distributed.

The pain of panophthalmitis, on the other hand, is usually less intense; the cornea is opaque from ulceration or inflammatory changes, which obscure the pupil and iris; chemosis is present; and there is much swelling of the eyelids and protrusion of the eyeball.

In plastic iritis the pain may be slight or severe; the pupil is contracted; the eyeball is red, the iris

discolored; and, on instilling a mydriatic, the pupil fails to dilate regularly on account of the presence of adhesions. On the other hand, serous iritis presents somewhat different appearances. There is pain, but it is not vehement; the pupil instead of being contracted is dilated; the anterior chamber is abnormally deep, and the posterior aspect of the cornea is covered with small spots of exudation.

Some of the pains associated with severe ear-disease are quite significant.

Thus, in mastoiditis (abscess of the mastoid cells) there is pain of varying intensity, which is most acutely felt directly behind the ear. Inspection of this locality, when the disease is at all advanced, reveals swelling and redness; while even moderate pressure demonstrates the existence of exquisite local tenderness.

It is self-evident that the prompt recognition of the true significance of this state of affairs is of the utmost importance, since it renders early operative interference possible, thus probably averting a fatal meningitis. In acute otitis media the pain in the ear is vehement, is increased by the recumbent posture, and usually ceases on operative or spontaneous perforation of the membrana tympani. That the pain is due to intratympanic pressure is revealed

by the bulging of the red and swollen drum towards the meatus.

In addition to these pains, there is an earache, which is obviously due to neuritis of the sensory filaments of the ear.

Carious teeth, post-pharyngeal abscess, and caries of surrounding bony structures may give rise to this kind of ear-pain.

Pains Referrible to Disease of the Organs within the Thorax.—Besides the pains which are associated with the extensive organic changes present in pulmonary cancer and phthisis, aneurism of the ascending aorta and mediastinal abscess, there are others which serve as warnings in a number of acute affections of both heart and lungs. Thus, in acute pleurisy, during the dry stage, we have local pain with the well-known friction sound and impairment of movement of the chest-wall. Later, in the stage of effusion, there is the usual dulness on percussion over the accumulated fluid; and in severe cases, displacement of the liver or heart.

Again, in acute pneumonia the thoracic pain associated with fever, cough, and the cherry-colored expectoration constitute an eminently characteristic group of symptoms. The diagnosis should not, however, be hastily made, the crepitant râles, the dulness with blowing respiration, increased vocal

fremitus, and bronchophony yielding the necessary confirmation.

Pain in the chest is also present in both acute and chronic pulmonary phthisis. In the former affection we find it associated with the usual premonitory chill, fever, anorexia, emaciation, and night-sweats; to which more or less irregular physical symptoms—dulness over a tubercular deposit, cavernous breathing, and moist râles—may be added.

Præcordial pain is a more or less significant symptom in affections of the heart and its membranes. Thus, in both acute pericarditis and endocarditis there is more or less pain. In the former affection it is associated, at first, with a more or less well marked friction sound, and later, as the pericardium becomes distended with fluid, with an increase in the area of percussion dulness. The characteristic pyramidal shape of this area of dulness, while the patient is standing, is one of the familiar observations of the sick-room.

In endocarditis the pain, while severe at times, is accompanied by a blowing instead of a friction sound; and later there is usually little or no increase of percussion dulness.

Finally, in all valvular diseases, especially aortic, in fibroid disease of the heart, in thrombosis of the pulmonary artery, and in cardiac affections of

purely functional character, there is more or less pain.

Pain associated with Disease of the Organs contained in the Abdominal Cavity.—In cancer of the stomach the pain is gnawing in character, and is felt with special intensity in the epigastrium. Much the same kind of pain is present in cancer of the pancreas, a fact which has often given rise to errors in diagnosis. It would lead us too far were we to enter into the details involved in the symptomatology of abdominal troubles; that is a task which we gladly assign to the systematic treatises on internal medicine. On the other hand, it may be of interest to recall the more important derangements of the abdominal organs in which pain of varying degrees of intensity is a noteworthy symptom. We have already spoken of cancer of the stomach and pancreas, both of which are accompanied by more or less continuous and severe pain; but, in addition to these, pain is conspicuous in a large array of other diseases of the abdomen. Prominent among these are the following: gall-stones, the passage of which produces severe epigastric pain which may be mistaken at first for colic. The location of the pain in the epigastrium, the presence of jaundice, the severe vomiting, and the comparatively brief duration of the paroxysm serve,

however, to characterize the latter sufficiently for diagnostic purposes.

Pain in the abdominal region is also a more or less striking feature of irritant poisoning, ulcer of the stomach,—especially manifest shortly after eating,—suppressed gout, acute gastritis,—likewise evident after the ingestion of food,—colic, cholera, enteritis, intussusception, the gastric crises of locomotor ataxia, lead colic, peritonitis, perityphlitis, organic diseases of the liver, aneurism, organic disease, and obstruction of the intestine. In the region of the pelvis we have, moreover, the characteristic pain which radiates from the ovary in a downward direction, and may extend, and usually does extend, to the anterior aspect of the thigh. This pain is commonly traceable to more or less severe disease of the ovaries, tubes, or both. It is, however, an unfortunate circumstance that extirpation of the diseased ovaries and tubes does not always result in a permanent removal of the neuralgia. It would seem that in such cases the irritable condition of the nerves involved is perpetuated by some extraneous factor as yet unknown to us. More or less severe pain in the region of the pelvis is also associated with cancer of the uterus, pelvic abscess, pelvic cellulitis, vesical calculus, dysmenorrhœa, acute and chronic endometritis, pelvic hæmatocele, fibroid dis-

ease of the uterus, cystitis, pelvic peritonitis, and the various displacements of the uterus.

In concluding this brief summary of the more important pains associated with diseases of the organs of the abdominal cavity, we must not forget those eminently characteristic and terrible pains which are associated with the passage of a stone of considerable size and roughness from the pelvis of the kidney through the ureter.

These pains shoot from the lumbar region, follow the course of the ureters, and may even extend as far as the testicles. They constitute the so-called "renal colic," and are by far the most striking feature of nephrolithiasis. The duration of these pains, as is well known to all physicians of experience, is contingent upon the length of time the stone remains incarcerated in the ureter. Sometimes a few hours suffice for the completion of the descent of the stone into the bladder; whereas at others several days, during which the patient is kept as much as possible under the influence of opiates, are necessary to complete the operation.

Pain associated with Organic Diseases of the Nervous System.—Pain is in greater or less degree a characteristic concomitant of most organic affections of the nervous system, and particularly those of the spinal cord. This is strikingly illus-

trated in acute spinal meningitis, where the pains in the back and along the course of the principal nerve-trunks constitute, with the distortions of the limbs and opisthotonus, due to the spasm of the muscles, a most characteristic picture. In the various inflammatory conditions of the cord, involving in greater or less degree the sensory mechanism, pain is a symptom of considerable importance. The terms acute, subacute, and chronic, as applied to myelitis, relate more particularly to the variable length of time required for the development of the symptoms; unusual vehemence of the pains and rapid evolution of the paralysis of the muscles, especially those of the lower extremities, as in transverse myelitis, coupled with bed-sores and bladder disturbances, being characteristic of the acute phase of the disease. The location of the pains will, of course, be contingent upon the seat and size of the central lesion; so that in a general way, it may be said, that the wider the distribution of the latter the greater will be the extent of the painful area.

Headache, paræsthesia, and lancinating pains in the limbs are comparatively rare in multiple cerebro-spinal sclerosis, but are characteristic of locomotor ataxia. In the latter disease, the so-called lightning pains, which shoot down the limbs, con-

stitute with the stamping gait, and other evidences of incoördination, a complex of symptoms so characteristic as to be hardly mistakable for any other disease. Tumors of the spinal cord do not, as a rule, give rise to marked sensory irritation in the beginning. After a time, however, when their location in the spinal cord is favorable, their presence is announced by the appearance of shooting pains, paræsthesia, and, eventually, anæsthesia; in short, by the series of phenomena known in the books as "root-symptoms."

Still later, the further compression of the cord, in consequence of the growth of the neoplasm, is shown by loss of power in the muscles, culminating at length in complete paralysis.

The resemblance of these symptoms, both in character and manner of evolution, to those of diffuse chronic myelitis, cannot have escaped the reader. Indeed, this similarity in the phenomena of the two diseases is so great as in many instances to preclude the differentiation of medullary tumor from transverse myelitis. Sudden exacerbations of pain and general irregularity of the symptoms are believed by some to be an indication of tumor; but little reliance can be placed upon this assumption, or upon that which perceives in irregularity of development a token of syphilis.

We may note in passing that the condition induced in the cord by pressure of the tumor is known as compression myelitis, and may likewise be engendered by caries and various injuries of the spine. As a matter of course, the intensity and rapidity of evolution of the pains and other symptoms will depend very largely upon the nature and extent of the injury or morbid change to which the myelitis is due.

As may readily be inferred from the character of the central lesion, pain is but a subordinate element of poliomyelitis anterior acuta, the paralysis and muscular atrophy being the significant features. It likewise occupies the same position in spastic spinal paralysis, the weakness in the legs, observed in the beginning, and the spasmodic condition of the muscles subsequently developed, with the inevitable sequences,—exaggerated tendon reflexes and ankle-clonus,—constituting the characteristic symptom group. Elsewhere will be found a description of the more significant pains due to organic changes in the brain, so that the subject need not be reopened.

Before terminating the discussion of the diagnostic relations of pain, let me say that the pains felt in the muscles are sometimes significant. Thus, in trichinosis, the muscular pains occurring at the

end of the second week or later are due to the myositis engendered by the parasites. It is true that when the number of trichinæ is relatively small the pains may be so slight as to remain almost unperceived. When, however, the invasion is extensive, the chain of symptoms is most characteristic. The muscles become enlarged and swollen; they are exceedingly painful and intolerant of pressure; and the same may be said of voluntary movements. Hence the patient remains in one position, avoiding motion as much as possible.

Inasmuch as the masseters, as well as the laryngeal and pharyngeal muscles, are involved, the subject experiences much difficulty in masticating and swallowing food. But a still more serious complication is the invasion of the diaphragm and abdominal and intercostal muscles by the parasites,—a condition which may cause such difficulty in respiration as to endanger the life of the patient. Undoubtedly, in some of the fatal cases of trichinosis, death is largely or entirely due to this interference with respiration.

Finally, the characteristic pains of muscular rheumatism are important, as they point to possible presence of redundant uric acid, thereby enabling us to effect in time the necessary modification in the dietetic regimen of the patient.

While the scope and purpose of this work will not admit of our pursuing the subject further, I think that enough has been said to illustrate in a striking manner the very great—I had almost said paramount—importance of pain as an element in general as well as neurological diagnosis.

CHAPTER VII.

THE CLINICAL AND MEDICO-LEGAL SIGNIFICANCE OF THE PHENOMENA EVOKED BY PAIN—OBJECTIVE METHOD OF DIAGNOSTICATING PAIN.

Inasmuch as it often happens that individuals, either of their own volition or on account of an hysterical predisposition, erroneously declare that they feel pain, it becomes self-evident that every sign, however insignificant, which can aid the physician in arriving at a true conclusion as to the sensations of the patient is of importance.

This objective determination of the existence or non-existence of pain is, however, often beset with difficulty: first, because—as in certain obscure phases of visceral pain—a possible cause is not demonstrable; and, secondly, because the secondary effects of pain—cardiac, gastric, nutritive, and psychic—are not at all or but slightly developed. The evolution of these collateral effects is indeed dependent not only upon the intensity of the pain, but also upon its continuance; so that it may very well happen that, when the pain is of brief duration and of

relatively minor intensity, little, if any, change in the corporeal or psychic condition of the patient is discernible. In a large percentage of cases of severe chronic pain collateral phenomena of this sort are, however, present; and when their existence as a direct sequence of the painful onset is demonstrable, they possess a distinct diagnostic value.

As the medico-legal significance of these things, though great, is often entirely overlooked, I shall take the liberty of enumerating the more striking facts.

In the first place, there are often well-defined appearances at the seat of pain. The most common are redness, heat, œdema, and tumefaction. Sometimes, however, as in myalgia, there are no local changes whatever discernible; and when the attack is acute, the testimony of the patient is about all we have to guide us.

Among the common effects produced upon the organism at large by severe and long-continued pain are chronic, or at least persistent, nervous irritability, imperative conceptions of a disagreeable character, hypochondria, and melancholia, culminating—as has often occurred in severe forms of tic douloureux—in self-destruction. Again, the subject may become the victim of obstinate insomnia, which in turn gives rise to moroseness, hallucinations,

and perhaps ultimately to complete mental alienation.

Although the facial expression of persons who are the victims of pain is not to be relied upon in a pathognomonic sense, it must nevertheless be admitted that the physiognomy often affords valuable data of a corroborative character; moreover, in the case of the deaf and dumb or the aphasic, or, above all, when little children are concerned, it may constitute our only source of information as to the patient's true state of feeling. When, however, malingering is suspected, the data to be gained from a study of the face of the subject are of no value. That this is so will be readily understood when it is remembered that such persons are able to assume the states of feeling which lie at the root of the facial contortions; so that, like actors, they are able to mentally "live in their rôle."

The character of the facial mimicry peculiar to those who suffer pain is so familiar to all physicians as scarcely to merit detailed description. Indeed, I question very much whether a mere analysis of the muscular contractions involved would begin to convey the definite impression obtainable from a good photograph or, better still, from the contemplation of the individual himself.

In addition to the psychical disturbances, grave

modifications in the physical economy have often been observed. Chief among these are the cardiac derangements, described by a number of authors and experimentally investigated by Franck and Claude Bernard.

Commenting on the discrepancies in the accounts given by different authors of these cardiac disturbances, Franck[1] observes that at all events the *immediate* effect is an arrest or slowing of the heart with the resultant changes in arterial pressure. He also confirms the previous observations of Magendie and Bernard, that excitation of the sensory roots or filaments of the spinal nerves gives rise to reflex stoppage of the heart with consecutive diminution in arterial pressure.

Precisely similar facts have been ascertained clinically. Thus, Potain drew attention some ten years ago to the palpitations and syncope which were the direct sequence of certain neuralgias and injuries of the arms.

Derangements of motility are a frequent concomitant or sequence of pain. This is especially exemplified by the tonic and clonic spasms so char-

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[1] Recherches expérimentales sur les effets cardiaques, vasculaires et respiratoires des excitations douloureuses, Comptes-Rendus des Séances de l'Académie des Sciences, vol. lxxxiii. p. 1109.

acteristic of the visceral neuralgias and so-called convulsive tic. The muscular contractions with which we are here confronted are clearly of reflex origin and require no special elucidation. The muscular relaxation sometimes encountered as an accompaniment of pain is much less characteristic and consequently of subordinate diagnostic value.

Disorders of nutrition, assuming the form of progressive emaciation, and loss of muscular and mental vigor, are familiar to all physicians.

Such vaso-motor anomalies as local hyperæmia or anæmia, more especially the former, are common phenomena of various painful conditions; and the same may be said of the derangements of the special nerves, particularly those of sight and hearing.

Arrest or appreciable diminution of the secretions, notably of the kidneys, is another well-known effect of pain.

The irritability, insomnia, melancholy, and other nervous and psychical effects of pain have already been alluded to. Dyspepsia, loss of appetite, and appreciable diminution of the activity of the salivary glands are some of the most common complications of various painful conditions. These gastric disorders are frequently accompanied by a considerable elevation of temperature, which has been justly ascribed to the intensity of the pain alone.

Finally, pain, when of great severity, may result in immediate death, the fatal termination being evidently due either to nervous exhaustion or syncope.

It would be a manifest omission were we to forget to mention what have been aptly termed *subjective pains*. Here we are confronted with painful sensations which are referred by the patient to definite localities, the most careful inspection of which fails to reveal any morbid changes whatsoever.

These so-called subjective pains, or "*phantom pains*" of the hysterical, are in reality nothing more than painful hallucinations, upon which, however, the subject, being ignorant of their genesis, is but too apt to construct erroneous ideas of various kinds.[1]

It must not be forgotten, therefore, that these phantom pains though of erratic development are none the less real to the subject herself. Hence undue harshness is to be avoided, and the same may be said of the old-fashioned expedient of taxing the patient with untruthfulness or other forms of moral turpitude.

Concerning the Method to be Pursued in the Clinical Determination of the Existence or Non-Existence of True Pain.—From what has already

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[1] *Vide* author's monograph on "Hysteria and Epilepsy."

been said, it is evident that the investigation of an essentially subjective phenomenon like pain is beset with no little difficulty. In the first place, it may be in consonance with the material interests of the patient to declare that he feels pain as the result of a real or imaginary injury. This has been witnessed again and again after railway or other accidents, when attempts have been made to collect large damages from corporations.

Again, in the absence of all criminal intent, as in certain phases of hysteria, the subject declares that she suffers acutely; and yet we are quite unable to discover, even by the aid of the most careful examination, any adequate cause for the alleged sensations. Here, as has previously been said, we have evidently to do with hallucinations pure and simple, the painful conceptions being of central origin, and directly traceable to some general neuropathic condition. Finally, the subject may declare that he feels pain in a certain definite locality. We examine the region in question, but find absolutely no lesion whatever; and yet the patient may be making his statements in perfect good faith, and he may even be in a condition of complete mental competency. In such a case as this, we should make every effort to determine, if possible, whether there be not some central irritation or organic lesion,

which may be held responsible for the morbid sensations, erroneously referred by the subject to the periphery. The pains of ataxia and of some forms of neuritis are illustrations in point.

And these preliminary observations bring us to the important question, How shall we conduct the clinical exploration in cases of suspected malingering, when pain is alleged to be the dominant or only symptom? I shall only attempt to give a general reply, leaving the elaboration of the special points demanded by individual cases to the perspicacity and tact of the physician. In the first place, let there be a careful examination made of the periphery, and more especially of the alleged site of the painful sensations. Now, experience has shown that much may be learned from careful palpation of the part, provided the patient be taken off his guard, so that the element of expectancy is excluded. To this end, it is well to engage him in conversation on irrelevant matters, so that the examination may appear as of quite collateral importance. By such an examination we are able to determine whether there is increased sensitiveness on pressure, whether there is inflammation, or whether there is tumefaction or other sign of gross lesion. As a further precaution against deception, the examination may be undertaken sev-

eral times, the agreement or discrepancies in the phenomena evoked serving as a basis of argument. The sensibility to temperature may also be tested in the same way.

Finally, we may administer in the food of the patient, or otherwise without his knowledge, an hypnotic of sufficient potency to remove the pain complained of. If in the face of this, after a sufficiently long interval to insure absorption of the medicament, he still declares that the pain persists as before or has increased in vehemence, we may conclude, in the absence of hysteria or other psychical defect, that wilful deception is in all probability being practised.

Let me also add that the failure of the collateral symptoms described by the subject to agree at all with any known type of disease is of itself calculated to arouse suspicion.

When all has been said, however, that can reasonably be said on the objective recognition of pain, it must be confessed that in some cases even the most expert diagnostician may find himself embarrassed.

CHAPTER VIII.

THE MEDICO-LEGAL RELATIONS OF PAIN, CONTINUED—SPINAL CONCUSSION.

In the majority of cases of surgical injury accompanied by pain the determination of the amount of damages consistent with equity is a comparatively easy matter, the degree of interference with the subject's occupation occasioned by the accident itself serving as a basis of computation, quite irrespective of pain or other collateral effect engendered.

When, however, the extraneous appearances of injury are little or not at all in evidence, the alleged phenomena being purely subjective, the difficulty of determining the genuineness of the latter is enormously enhanced. These observations are especially applicable to the curious affection of the nervous system which is the sequence of railway or other accidents, and to which the name "spinal concussion" has been given. Let me say, however, at once that, in my opinion, "cerebro-spinal concussion" would be a designation more in accordance with the symptoms, since not a few of these

are clearly due to derangement of the intracranial structures.

Since this spinal, or cerebro-spinal, concussion has probably given rise to more litigation than any other painful affection, it is eminently important that every physician should at least be thoroughly acquainted with its more important features. I have therefore decided to devote a short chapter to its consideration, which, should the reader be already acquainted with the subject, may be passed over.

Symptoms.—If a man be suddenly precipitated from an elevation, so that he strikes with violence upon his back, or if he be caught between two seats of a railway car in the course of an accident, so as to bruise, say, the lumbar portion of the spine, a train of grave symptoms may be developed pointing to more or less profound derangement of the functions of the cord. There may be immediate paraplegia or some other phase of paralysis; there may be retention of urine; there may be various forms of paræsthesiæ,—formication, numbness, or even total anæsthesia of the affected parts; or, finally, there may be paralysis accompanied by one or more of these phenomena. Sometimes, too, after a certain amount of febrile disturbance of brief duration, the symptoms begin to abate, and

eventual complete recovery takes place. Again, the termination may not be so favorable. We may have to do with more or less persistent dorsal pain, with numbness or sensations of pins and needles, accompanied by depression, derangements of memory, and other symptoms pointing to profound implication of the cerebro-spinal system. The spinal tenderness present in such cases is often of an exquisite and obstinate character. If, in addition to direct concussion of the spine, a blow upon the head has also been received, it not infrequently happens that, in the course of time, epileptiform seizures are added to the cord symptoms. The clinical history is, of course, somewhat changed by such a complication, and the same may be said of the prognosis, which is much clouded. Finally, the blow upon the spine may be but slight or altogether absent, the subject being merely thrown violently about, as in certain railway accidents. Under these circumstances the symptoms are often slowly evolved, and, though frequently less severe than when the sequence of a direct and violent traumatism, they nevertheless partake of an insidious and lethargic character, which puts the patience of both client and physician to a severe test.

Accidents of this class have now become common, in consequence of the manifold complications of

modern society, and especially of those which relate to transportation.

As already noted, the painful localities along the spine, which are such constant features of these cases, are eminently worthy of the attention of the physician, since they bear a significant relation not only to a scientific diagnosis, but to effective therapeutics as well.

At this portion of the discussion I believe that I cannot do better than cite a case or two from my own case-book by way of illustration.

H. C., merchant, aged fifty-two years, of strong muscular constitution, consulted me in February, 1884, for a train of severe nervous symptoms, which caused great anxiety both to himself and family.

The following are the more prominent points in the history of the case:

One year previous to consulting me he had the misfortune to travel on a railway train which met with a serious accident. The casualty in question, as it afterwards appeared, was caused by the spreading of the rails immediately in front of a long trestle-work. Several of the coaches were thrown from the trestle into the water, many of the occupants being caught between the seats or thrown about and severely injured. Others, again, were confined beneath the flying débris and drowned;

while yet others succeeded in making their escape from the windows of the coach. Among the latter was a distinguished officer of the United States army and the gentleman with whose history we are now concerned. Had the coach, after striking the bottom, not rolled over upon its side, it is probable that those within, who had not been killed outright, would have perished by drowning. As it happened, however, a large proportion of those within the submerged cars escaped with their lives. It cannot be said, however, that these persons were all unscathed, for, though the wounds received were in most cases not serious, the after-effects caused by the violent shaking were of a severe character. Among those who developed severe symptoms a considerable time after the accident was the gentleman who forms the subject of this brief history. On emerging from the water, he became conscious that the right shoulder and the lower portion of the back were somewhat stiff and sore. At the same time he felt a dull pain throughout the whole dorsal region. These pains and the accompanying soreness in the shoulder soon disappeared, however, and the patient was beginning to regard himself as perfectly well, when, several weeks after the accident, he complained of numbness in the third, fourth, and fifth fingers, particularly pronounced in

the right hand. This numbness was accompanied by tremor of both hands, evoked by every attempt to execute voluntary movements. At the same time, he experienced "dull, tired" feelings after walking even short distances, accompanied by great mental depression. As a coexistent factor of the above symptoms, the patient remarked a progressive decline in his sexual powers, so that, at the time of visiting me, his abilities in this direction were *nil.* The testicles seemed unusually small, the scrotum was tightly contracted about them, and the penis was retracted, so as to expose only about half an inch. Altogether, the sexual apparatus was in size and general appearance analogous to that of an infant. On examining the spine, no great tenderness could be discovered; but on passing the wire brush along the spinous processes, from the cervical region to the sacrum, an exceedingly tender point was discovered in the neighborhood of the eleventh dorsal vertebra. The course of this case was a long and tedious one.

Sleep being profoundly deranged, the patient was placed on twenty-grain doses of the bromides, to be taken three or four times a day. Small doses of chloral were also given at night, during the first few weeks of treatment, combined with the tincture of hyoscyamus. Strychnine was not well borne, and,

according to the patient's statement, exaggerated the lumbar pains. In order to relieve the latter, blisters were applied throughout the painful region, but without greatly diminishing the spinal soreness. Prolonged applications of galvanism were more effectual in abating the irritation; and accordingly the constant current was applied every other day for two months, at the end of which time marked benefit had been obtained. The tingling and numbness of the limbs remained for some time longer; but after the lapse of four or five months it, too, had entirely vanished. Walking had also begun to afford pleasure, and could be indulged in without the fear of subsequent lassitude.

The most difficult complication to combat in this case was the complete loss of sexual power, accompanied by the retraction of the organ. This retraction of the penis was certainly phenomenal, as already observed. In order to remedy the condition dry cupping of the penis was resorted to, and continued daily for over three months, and every other day for the subsequent four months. By the aid of this treatment, combined with douches, the passage of the cold sound, such remedies as the chloride of gold, iron, and the cocoa preparations, I finally succeeded in completely restoring the patient's sexual powers, so much so, in fact, that

in due time a further addition was made to his family.

This case affords an excellent illustration of the slow insidious onset of the affection, of the evolution of severe and obstinate symptoms without local traumatism of commensurate importance, and, finally, of the ultimate success attending the treatment of what at the outset had all the features of a practically hopeless case. This patient remained under my immediate care nineteen months. At the end of that time, with the exception of occasional attacks of depression, the cure was complete. Since discontinuing treatment I have seen the patient from time to time, and some months ago he informed me that these attacks of depression had entirely left him, and that, in short, he is "as well as he has ever been in his life."

The following case, also taken from my case-book, is a good illustration of some of the milder phenomena sometimes evoked by concussion. As in the cases already cited, marked localized tenderness of the spine was present; but the condition was treated in a more direct and effective manner.

J. M., a married man of forty-five years of age, of nervous temperament and slight physique, consulted me four years ago on account of a train of nervous symptoms which caused him both anxiety

and annoyance. The salient points in his case were these:

About eighteen months before consulting me he had met with an accident on the Long Branch Railway. He was violently thrown about the car; his head was cut, and he received a severe bruise in the left lumbar region. On extricating himself from the wreckage, he noticed that his legs felt "sleepy" and that there was a tingling sensation in the right side of the face. These sensations disappeared entirely within the following week, so that he was able to resume the obligations of an active business life. All went well for a time, the duties of society and business receiving a punctilious attention, which had never been exceeded, even when the patient enjoyed the most perfect health. Some five months subsequent to the accident, however, he began to complain of great lassitude, particularly during the early morning hours. At the same time sleep became profoundly deranged, and even when he was certain that he had slept for a few hours, he complained that his sleep "did him no good." Formerly of a cheerful disposition, he now became the victim of protracted periods of depression; and his memory, previously of average strength, had become so fickle that he was obliged to carry a notebook in which to record his most trivial routine

engagements. He also suffered from soreness of the back and occasional attacks of facial neuralgia.

On examination, his muscular system was found to be weak and flabby, his heart's action feeble and irregular, and his general condition one of pronounced anæmia. Pressure along the spinal column revealed two points of marked soreness, the one in the dorsal region, the other at the level of the second lumbar vertebra. From the first of these tender spots radiated—especially on sudden changes in temperature—intercostal pains of considerable intensity.

Having placed the patient on a tonic regimen and prescribed the iodide and bromide of potash, the latter to be taken in cumulative doses during the afternoon and evening, I directed my attention to the points of tenderness in the spine. Instead of treating these by the long and tedious method of local galvanization, I decided to try the efficacy of local injections of cocaine and pyrogallic acid in solutions of low percentage. I will merely add that I succeeded in affording much relief to the patient; so that, after the injection had been repeated a few times, the soreness disappeared entirely.

When I compare the promptness of the relief obtained in this case with the long course of pallia-

tive treatment required in the case detailed at the beginning of this chapter, I am the more surprised that greater efforts have not heretofore been made to influence the functions of the cord by resort to more direct methods.

Having thus detailed some of the complications often encountered in even the milder phases of concussion of the spine, it now becomes necessary to leave this interesting field, for it is self-evident that to pursue the matter further would be to transcend the natural limits of a work of this general character.

CHAPTER IX.

OF THE INSOMNIA AND MELANCHOLIA OF PAIN.

We have already referred in previous chapters to the nutritive and cardiac disturbances, both of which are so frequently evoked by severe pain, especially when long continued. But there are other sequences of pain which are, if anything, even more important than these; and this may be said especially of the sleeplessness and melancholy so often met with in the course of painful affections. I repeat that these two complications are invested with unusual significance from a prognostic point of view; for it not infrequently happens that singly, but more often together, they are the forerunners of suicide or insanity. In view, then, of the gravity of their significance in this respect, it will not be time misspent if we devote a short chapter to the consideration of insomnia and melancholia, more especially as they occur as the direct result of pain.

For the sake of convenience, from both a physiological and a clinical point of view, insomnia may be divided into an idiopathic and a symptomatic variety.

In idiopathic insomnia the etiological conditions, though not always discoverable, reside apparently in the brain itself, since factors extraneous to that organ, which might account for the occurrence of the sleeplessness, are entirely wanting.

Symptomatic insomnia, on the contrary, is traceable to sources of irritation outside the cranial cavity. This is the variety of sleeplessness which we encounter in the course of painful affections, especially those of long duration.

It will be well to examine the phenomena of these two varieties of insomnia somewhat more in detail.

As has been previously noted in connection with the discussion of the phenomena of pain, it often happens that the painful paroxysms exhibit remarkable regularity in their occurrence, the most frequent manifestation of this periodicity being the appearance of the seizure at a certain time in the evening. Under these circumstances, the patient passes the greater portion of the day in a condition of lassitude, but also of comparative exemption from suffering.

The skin has usually a dull sallow appearance, and the eyes are sunken and devoid of their normal lustre.

The urine is often scant and highly colored,

and a constipated habit is the usual but not invariable rule. Exceptionally, there may be obstinate diarrhœa, which contributes not a little to the general enfeeblement of the subject. In the idiopathic variety of insomnia, the lassitude during the interval of wakefulness is quite characteristic, amounting, as it often does, to the most pronounced lethargy. Uncontrollable yawning is present in almost every case. When expostulated with on account of his listlessness, the subject becomes morose and sullen, regarding the well-meant advice as an impertinent interference. The small ills of life assume commanding proportions, and by a system of loose, pessimistic reasoning he is led to regard them as the forerunners of an impending catastrophe.

On betaking himself to bed, sleep fails to put a quietus to the gloomy train of thought; he tosses from side to side; he removes the bedclothes; he replaces them again; he changes his position a hundred times, all in a vain attempt to win unconsciousness. When at last, after a prolonged vigil, sleep supervenes,—partaking, as it inevitably does, of the perverted cerebration of the previous hours of wakefulness,—it utterly fails to refresh the subject either physically or mentally. Indeed, from an extensive practical experience with the various

derangements of sleep, I am convinced that perverted dreams and unconscious cerebration are more frequently encountered in the sleepless than among any other class of sufferers. In view of the imperfect nature of this sleep, it is not surprising that daylight finds the subject completely prostrated, and quite unable to resume his accustomed activities with even moderate energy.

Tea, coffee, brandy, and even morphine are now invoked with the hope of obtaining a renewal of vigor. But the relief thus obtained is necessarily transitory, since there is no known stimulant capable of replacing the regenerative processes in the cerebral ganglia which are carried on during normal sleep.

The temperament of the individual has, as may readily be conceived, an appreciable influence in determining the character of the attack. When he is predominantly emotional, the insomnia is of a far graver kind than would be the case were the mind of an essentially intellectual cast. Worry, adversity, and suspense are, indeed, things which are especially disastrous to emotional persons, whose powers of adaptation in the face of such exigencies are limited.

Precisely the opposite is true of those in whom the ratiocinative faculties predominate; for, when

they are assailed by an acute attack of insomnia, we find such persons much less irritable and depressed, simply because the emotional element in the psychical organization is either inhibited by the reasoning faculties or is practically wanting.

Finally, as may be readily deduced from the foregoing remarks, a vivid imagination is certain to add to the severity of an attack of insomnia; since the fancy, instead of becoming progressively subdued, increases in activity, with the result that myriads of fantastic, semi-incoherent ideas arise spontaneously, disappearing again, but only to return with new combinations added to their grotesque array.

Such is a true picture of idiopathic insomnia; and I may add, also, that many of its attributes are likewise common to the symptomatic type of sleeplessness, which it will now be well to consider briefly.

Symptomatic insomnia, as its name implies, is that form of sleeplessness which accompanies chronic affections, especially those in which pain more or less severe or long continued is a prominent feature.

As most persons are aware from personal experience, sensory impressions should be eliminated as far as possible in order to insure the occurrence of the most perfect type of sleep. Hence, when there is present neither irritation within nor at the surface of the body, and when, moreover, there is an

absence of impressions through the special senses, it is evident that the physiological requirements of the proposition are fulfilled.

During normal sleep, it is true, the perceptive mechanism is obtunded, because of the exhaustion due to the previous stage of activity, and, as a consequence, slight sensory impressions which during wakefulness would have led to active perception leave no imprint upon the sluggish protoplasm. When, however, impressions of considerable intensity are transmitted to the exhausted receptive centres, the latter become irritated and aroused from the lethargy consequent upon exhaustion, and finally the entire cerebral mechanism is aroused: the individual is awakened. Herein lies the explanation of the sleeplessness engendered by pain, which, as indicated in an earlier chapter, is nothing more nor less than exaggerated common or special sensation. But even in cases where the pain is slight, but of relatively long duration, wakefulness of a distressing character, coupled with irritation of the central nervous system out of all proportion to the exciting cause, may be engendered. An excellent illustration of this fact is afforded by the insomnia due to the application of blisters, concerning which Dr. Robert J. Graves wrote in the following suggestive way over forty years ago: "The bad effects on the

nervous system occasionally produced by the application of blisters are somewhat analogous to those which result from wounds and other external injuries, and to be accounted for on the same principle. . . . The delirium and sleeplessness arising from blisters constitute a by no means uncommon disease."

It is quite evident, then, that irritative processes involving the terminal organs of the centripetal nerves represent the pathological factor of chief importance in the genesis of secondary insomnia. Hence it follows that those acute and chronic diseases which are accompanied by severe or prolonged pain are the most prolific sources of this variety of sleeplessness.

The Melancholy of Pain.—When a person has suffered acutely for a short time, or, as more frequently happens, when the pain has been of less severity but of longer duration, a condition of mental atony may be engendered, ranging from more or less irresponsiveness to ordinary impressions to melancholia,—simple, delusional, or suicidal.

With these conditions of depression occurring in the course of, or as the sequence of, painful affections the physician is often enough confronted. The subject, therefore, is clearly invested with prac-

tical interest; and for this reason I believe that no apology will be required for the insertion of the following brief remarks.

Simple and Hypochondriacal Melancholia.—This is by far the most common form of depression encountered in the course or as the sequence of vehement or prolonged pain. Its most striking characteristic is a predominance of purely emotional disturbances, the intellectual or volitional aberrations being little or not at all in evidence. In the beginning the patient suffers from loss of appetite and constipation, followed, in a short time, by more or less disturbance of sleep and listlessness during the day. Though formerly, it may be, of an energetic, sanguine disposition with definite predilections, both as regards work and amusements, he now manifests a positive dislike for all pursuits; and this aversion may culminate in change in propensities and ideals. This inversion of the instincts may be exhibited in dislike for the familiar associations of the family, by irascibility, by loss of courage, and by distaste for society. Loss or at least marked decrease of sexual vigor is a striking feature at this time, and the same may be said of the diminution in weight and augmented sensitiveness to cold, which latter feature leads the subject to dislike bathing in water of low temperature, subse-

quent reaction being but slightly marked, or even entirely absent.

Like the neurasthenic, the subject of melancholia is usually worse in the morning than at night, when, for some unaccountable reason, there is a partial though temporary revival of vigor. The lustreless appearance of the eyes, the coated tongue, the dry, inactive appearance of the skin, the mental inertia, the emotional irresponsiveness, may all be observed during these early hours, and they constitute a complex of symptoms so characteristic as to be practically unmistakable.

Not only is the initial period of simple melancholia to be looked upon as of essentially sane character, but, in a large percentage of cases, the entire course of the disease must likewise be so regarded. This at least is true in the light of currently-accepted definition. The same may likewise be said of certain mild phases of *hypochondriacal melancholia*, where the erroneous ideas are shifting in character and devoid of the inherently impossible character exemplified by the more serious varieties of the affection. Where this grave delusional type of the disease prevails, the subject may proclaim that he has three stomachs or none at all, that "his liver fills the entire abdominal and thoracic cavities," that "he has seven kidneys," and the like.

The shifting, less preposterous types of hypochondriacal delusion are those most commonly evolved in the course of painful affections. They consist for the most part in abortive attempts to explain the origin of the painful sensations; and, though unscientific enough in themselves, are nevertheless well within the limits of mental sanity, for they are no worse than might reasonably be anticipated from persons ignorant, or largely ignorant, of medical matters. Thus, we find ataxics strenuously insisting that their pains are due to "rheumatism," and sufferers from lumbago declaring that their "kidneys are affected," in the face of the most conclusive proof to the contrary. As we have said, these things are common enough as the sequence of pain, especially of a prolonged, unyielding type; but since they are rarely the precursors of serious consequences, nothing more than a humorous consideration is usually accorded them.

Suicidal Melancholia.—Self-destruction represents the culminating catastrophe, the most drastic expression of mental depression. That this is indeed the truth will be readily conceded when it is remembered that the love of life, the instinct of self-preservation, is the strongest impulse in man, as well as the lower animals. When this fundamental instinct is obliterated, or even reversed, so that the patient

is not only indifferent to life, but actually craves death, the change in the affective and instinctive faculties is certainly the most profound imaginable.

The motive which impels the subject to desire or attempt self-destruction is, however, not always the same. Sometimes it assumes the form of a desperate attempt to avoid imaginary evils; or it is the outgrowth of an imperative and often sudden impulse; or, as sometimes undoubtedly happens, it is the result of a deliberate process of reasoning.

The last-mentioned motive is that most frequently encountered in severe intractable pain, as we find it, for example, in *tic douloureux*. In despair at the fruitless efforts to obtain relief, and worn out by ceaseless vigils, the horrors of which are too great to be expressed in words, the unfortunate grasps deliberately at death as the sole means of obtaining release.

The essentially sane character of the ratiocination which has led to the unnatural and tragic ending is revealed by the epistles written by such persons immediately before the commission of the fatal deed.

Delusional Melancholia.—By this designation is to be understood that form of melancholy in which one or several delusions are the most striking feature from the beginning. Indeed, it is this early appearance and prominence of the erroneous

ideas which leads those unfamiliar with mental pathology to regard the general morbid condition as the sequence of the delusions. This, however, is crude reasoning, as the persistent disturbance of cerebral nutrition is the principal thing.

As this form of melancholia is, however, much more rarely met with in painful conditions than the varieties of depression previously described, it will not be advisable to pursue the subject further.

In the following chapter the means at our disposal for dealing most effectively with those two distressing complications of pain, insomnia and melancholia, will be considered with much fulness.

PART II.

THE SPECIAL THERAPEUTICS OF PAIN.

CHAPTER X.

CONCERNING THE IMPORTANCE OF REST IN THE TREATMENT OF THE NERVOUS SYMPTOMS ENGENDERED BY PROLONGED AND SEVERE PAIN.

In the previous chapter the insomnia and melancholy which constitute such important sequences of severe and protracted pain have been considered at some length. What has there been said has served, I trust, to exhibit the exceeding importance of the subject, so that further insistence on that point is unnecessary. Nothing, however, has yet been said of the best manner of dealing with those complications; this we shall now attempt to do as succinctly as possible.

Let me say, then, at once, that in my judgment the most effective means of neutralizing the ill effects of both the melancholy and the sleeplessness

engendered by protracted pain is found in the series of expedients commonly grouped together under the general designation of "Rest," or the "Rest Treatment."

But, as there has been much crudeness in the conceptions entertained by many as to the significance of these terms, I shall take the liberty of discussing the whole question of rest with some elaborateness, trusting that by so doing I shall be able to remove some of the nebulousness which has surrounded the whole subject, alike in its physiological and clinical relations.

Of Rest in General.—When we associate the idea of rest with a mechanism, we involuntarily think of cessation of motion. When, however, we speak of rest in connection with living organisms,—when we employ the term in its true physiological sense,—not only does the element of functional quiescence enter into the conception, but that of repair as well. The demonstration of the truth of this idea has been one of the many services of modern physiology. Still, it must be admitted that mankind has always entertained more or less true, though crude, ideas of the nature of rest as exhibited by living beings.

The laborer, after the noonday remission, is conscious of reinvigoration, is aware of certain changes

in his stiffened and unwilling muscles which render the latter supple and serviceable once more. The student or weary professional man, after a night's sleep, becomes aware of certain changes in his mental mechanism which enable him to resume intellectual labor with positive enjoyment.

It is clear, therefore, that such familiar facts as these must at an early date have led men of intelligence to associate the idea of repair with that of rest. The conception was, however, more or less vague; and not until modern experimental physiology had shown the inseparable relation between function and tissue metamorphosis did crude surmises give place to definite scientific proof.

One of the greatest practical benefits accruing from the knowledge of the physiological significance of rest has been the adaptation of such rest to the treatment of disease. Now, the fulfilment of the requisites of physiological rest, when applied to the organism as a whole, is a simple matter. In short, we have merely to pay heed that there be neither an excess of mental nor physical work; and then, translating the word "repair" into "nutrition," it only remains to see to it that the individual is provided with food of a kind suitable to the reparative exigencies of the organism at large. When, however, it becomes expedient to afford

rest to a single organ, for example, the solution of the problem is by no means so simple; for we have then to "rest" a particular physiological system over and above the remainder of the economy, and, at the same time, to make provision for the specific nutritive demands of the organ which we desire to benefit. It follows, therefore, that, clinically speaking, there is not one system of rest, but, on the contrary, there must be several. In the following paragraphs I shall consider three kinds of rest: (1) muscular rest; (2) spinal or medullary rest; and (3) cerebral rest.

Muscular Rest.—This is the simplest of the three forms of rest which we are about to consider, and its realization makes demands upon none but the most ordinary resources of therapeutics. The day-laborer who has passed many hours in toil experiences a certain amount of fatigue in the muscles,—a local weariness which is relieved in a short time by keeping the muscles in a state of simple quiescence. This is not, however, the form of muscular rest which the physician has occasion to employ in practice; for instead of healthy, robust muscles, he has usually to do with a flabby, ill-developed muscular apparatus requiring attention of a special kind. In dealing with this latter class of cases, it is first necessary to cause a sufficient flow of blood

through the ill-developed muscle to facilitate repair of the stunted organ; and, secondly, it is advisable to place the latter in a state of complete repose for a considerable length of time after the blood-current has been diverted, so that the processes of repair may be realized to their fullest extent. The derivation of the blood-current for the benefit of the muscle may be accomplished in a variety of ways:

1. The patient may be urged to employ his muscles in vigorous exercise for a certain length of time, and to follow such exercise by more or less complete repose of the motor apparatus. This is the system pursued in gymnasia and in the training preceding athletic contests; to its beneficial influence is to be ascribed the enormous muscular development often attained by men of sedentary pursuits.

2. By resort to profound and vigorous massage it is possible to cause a copious flow of blood to the muscles. This method of derivation is the most generally applicable, and will be found useful in the treatment of a large class of feeble individuals.

3. Finally, the blood-current may be caused to flow through the muscle in copious measure by means of Junod's apparatus,—a method of treatment which has, however, a more or less restricted application, being perhaps best adapted

to the management of peripheral paralysis associated with muscular atrophy.

There is one other factor of importance in connection with muscular rest,—viz., the introduction of proper nourishment into the system. Where the stomach is in good condition there is no great difficulty in solving this portion of the problem. The patient is to be put upon a diet consisting largely of meat, eggs, and milk, a menu which may be varied from time to time to suit the varying wants and idiosyncrasies of the patient. Should the stomach prove recreant, or should that organ have been the seat of severe and long-standing dyspepsia, resort may be had to rectal alimentation. In addition, we may employ subcutaneous injections of cod-liver oil with a view to further improvement of the processes of nutrition.

Spinal Rest.—A moment's reflection upon the offices of the spinal cord will serve to show that any system designed to afford physiological rest to that organ must fulfil a twofold end,—viz.:

1. The elimination of those motor and sensory impulses which under ordinary circumstances are transmitted through the conducting paths of the cord; and,

2. The curtailment, as far as possible, of reflex action.

The requisites of physiological cord-rest are very well realized in the system adopted by Dr. S. Weir Mitchell. The essential features of this system are the combined use of rest, massage, electricity, and over-feeding.

As regards the utility of Dr. Mitchell's method in the treatment of functional affections of the spinal cord, there can, I believe, be but one opinion. It is impossible, indeed, to say too much in praise of it when thus employed. As to its applicability in the treatment of those affections which are unquestionably cerebral in origin and directly traceable to exhaustion, irritation, and other forms of malnutrition of the brain itself, that is a matter which I believe is open to serious question. But of this I shall have something to say at a future stage of the argument.

Cerebral Rest.—It is clear from the foregoing remarks that, as applied to the brain, rest means something totally different from that which is understood by the term when used in connection with the muscle, the joint, or the spinal cord. This radical difference is chiefly owing to the fact that, the brain being the organ of the intellectual processes, rest, in so far as it concerns that mechanism, means nothing less than a cessation of mentalization, with all thereby implied. It is impossible by a mere fiat of the will

to cause cessation of thought; the very idea itself embodies a contradiction; for will itself, as physiologically understood, is not to be looked upon as something *sui generis*, as an abstract impalpable unit, but rather as the outgrowth of a series of exceedingly complex psychical processes. From this proposition it follows, therefore, that the exercise of will is quite as much a consumer of cerebral energy as the mental processes which are necessary, for example, to the solution of a problem in Euclid. The same may be said of consciousness and the impressions which underlie it. To sum up the argument, the whole drift of modern psychical and physiological research goes to show that all phenomena known as mental are contingent upon a consumption of cerebral energy. It now becomes pertinent to inquire:

1. Does nature provide an intermission in these mental processes? and,

2. If so, can such cessations in cerebral activity be induced or prolonged, and finally utilized, in the treatment of functional brain affections?

To the first question the reply is sufficiently obvious: nature does unquestionably afford more or less complete repose to that portion of the cerebral mechanism engaged in the evolution of mental phenomena; such repose being undoubtedly the

chief office of sleep. True, it is questionable whether absolute quiescence of the mental faculties is always attainable, even during sleep; the ideal rest afforded by the latter being frequently marred by the occurrence of dreams and more or less unconscious cerebration. Still, the fact remains that during sleep cerebration is at a minimum. Then again, unconscious cerebration and dreaming are after all to be regarded rather as exceptional features than as physiological phenomena of sleep.

To the second question, Can a cessation in cerebral activity be induced and prolonged? I reply, most certainly, and that too without inordinate drugging, which is considered so indispensable by those little accustomed to deal with insomnia, exhaustion, and other anomalies of nutrition affecting the cerebral centres. Before entering upon a description of the scheme of treatment by which I have sought to practically realize the benefits of cerebral rest, I desire to cast a retrospective glance at my early publications on the subject, as certain of them seem to have given rise to some misunderstanding.

In 1882 I published a brief article[1] in which were detailed sundry experiments undertaken by myself

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[1] Medical Record, February 18, 1882.

with a view to elucidating certain problems connected with cerebral physiology.

On a subsequent occasion[1] I added, "If it be admitted that the ganglia are directly or ultimately dependent for their functional activity on the good offices of the blood-stream, it becomes perfectly evident that limitation of blood-supply means curtailment of ganglionic function." By this statement I did not wish to imply that cerebral rest, in a clinical sense, was to be obtained by simply causing anæmia of the brain; my sole desire was to draw attention to the well-established fact that the oxidative processes within the cerebral ganglia are diminished during the repose of the latter, and that the anæmia of sleep, though occurring as a consequence of the exhausted condition of the ganglia, was not, therefore, to be regarded as of no importance in the chain of physiological events. A few months after the publication of this little memoir I took occasion to give further expression to my views relative to the physiology of sleep. On that occasion I said that the two most important factors of sleep are ganglionic exhaustion and a physiological degree of anæmia.

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[1] Carotid Compression, Anson D. F. Randolph & Co., New York, 1882.

The experimental data which I cited in corroboration of these views were not derived from the observations of others, but were mainly the outgrowth of personal investigation and experience in the clinic. I felt, therefore, that, if treading upon ground of acknowledged difficulty, I was at all events not trusting to the fickleness of mere deductive reasoning. The logic of subsequent events has in no wise shaken my confidence in the opinion then expressed, so that, at the present, I see no reason for changing the tenets upon which the system of cerebral rest—presently to be described—is essentially based.

The practical problem of cerebral rest I have therefore sought to systematize as far as possible, but in communications on the subject I have not omitted to exhibit the many-sided aspect of the question. Thus, in a paper[1] published in 1883, I took occasion to show the paramount importance of systematized, physiological rest in the treatment of aggravated cases of cerebral exhaustion. I showed, moreover, that the essential feature of such a system was *prolonged* sleep. In a paper[2] read

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[1] "Exhaustion of Brain Energy," Medical Record, April 7, 1883, vol. xxiii. No. 14.

[2] "Brain Exhaustion," New York Medical Journal, December 29, 1883.

before the Medical Society of the County of New York, November 26, 1883, I took occasion to enter somewhat more into details. For the sake of brevity I extract from the above paper the following description of the scheme of cerebral rest presented on that occasion:

The essential features of this system are, 1. Cerebral rest (prolonged sleep); 2. Increased general and cerebral nutrition; 3. Elimination of psychical irritation and sensory impressions, particularly those of light and sound (isolation of the sensorium).

General Description of Treatment by Cerebral Rest.—The subject is isolated in a darkened room, eventually from ten to fifteen hours at a time, according to the amount of sleep which it is desired shall be had during the twenty-four hours. The amount of sleep is progressively increased by habit, hydro-therapy, appropriate food, and moderate medication. When I speak of appropriate food, I mean such aliments as exert a demonstrably soporific effect, such as the various preparations of hops and the different kinds of dishes in which lettuce is employed as a principal ingredient; hence salads, etc. It is impossible to over-estimate the importance of a carefully-regulated diet in a system of treatment, the corner-stone of which is prolonged sleep,—that is, sleep protracted far beyond what is common or

necessary to the welfare of persons in ordinary mental health. In the books which ostensibly treat of sleep and its disorders, reference is sometimes made to the digestibility of food as related to that function. But among the various papers and books treating of insomnia which have come under my observation I have found no reference to the direct, promotive influence exercised by a goodly number of aliments upon the function of sleep. The soporific effects of some kinds of food are indeed of the most striking character, and I feel justified in stating, after an extensive experience in these matters, that one cannot hope to cope with the ordinary problems of insomnia, much less with those presented in the course of treatment by prolonged sleep, without first thoroughly mastering this aspect of the subject.

As to sedatives and other forms of medication, I can only say that I resort to them as little as possible. In cases of functional brain-trouble, complicated by inordinate irritability and worry, I am in the habit of giving the bromides in moderate doses during the day, with a view of bringing the brain into a condition of sufficient tranquillity towards evening to render the supervention of sleep possible.

In conjunction with coca, I have used the preparations of absinthe (usually the extract) for the pur-

pose of allaying the worry and depression which are at times such distressing features of insomnia, cerebral irritation, and exhaustion. On this point I shall have something further to say in the section devoted to internal therapeutics. I will only add, in this connection, that I never attempt, by the reckless use of sedatives, to produce that form of unconsciousness which has been called sleep, but which, after all, bears a far closer kinship to stupor.

When the patient awakes, which may occur not at all or two or three times during the hours set apart for rest, nourishment is administered; but the latter is always not only digestibly prepared but, what is of hardly less importance, it contains a soporific adjunct such as lettuce.

As a matter of course, the amount of sleep required is necessarily not the same in all cases; in a considerable percentage of persons under treatment, from ten to fifteen hours in the course of the day will prove sufficient. I have, however, in exceptional cases, prolonged the quotidian period of unconsciousness up to eighteen hours; and in a recent case of severe cerebral exhaustion, which was referred to me for treatment, I succeeded in inducing unconsciousness for a period of twenty-one hours out of the twenty-four, and that without excessive medication, unless hydrotherapy, soporific

alimentation, and isolation in a perfectly dark room be so denominated.

At this point in the discussion it will be appropriate to say a word concerning isolation as I understand it, which I need hardly say is in a wider sense than that usually imputed to the term.

The Isolation of the Sensorium from its Environment.—The less the exhaustion of the brain-cells the greater will be the power of all sensory impressions to cause wakefulness. The truth of the above proposition has been amply proven by the experiments of Kohlschütter.[1]

It is clear, then, since sensory impressions only fail to cause wakefulness when the exhaustion is great, and hence the state of unconsciousness profound, that, therefore, the occurrence of such impressions in persons who exhibit but slight predisposition to unconsciousness must be detrimental, if not absolutely fatal, to sleep. As a natural consequence, it follows that the elimination of sensory impressions of all kinds is absolutely necessary if we desire to procure protracted sleep for those who are "light sleepers," or who are sufferers from chronic insomnia. I have been thus explicit in

[1] Messunger der Festigkeit des Schlafes, Inaugural Dissertation, von Dr. Ernst Kohlschütter, Leipzig, 1862. See also criticisms upon the same in Schmidt's Jahrbücher, 1863, vol. cxviii.

order to demonstrate that not only is it expedient, as Dr. Mitchell has shown in the case of hysterical women, to separate the patient from her friends, in order to eliminate the deleterious influences arising from ill-judged sympathy, but, what is still more important, *it is necessary to eliminate peripheral impressions of all kinds*, particularly those arising from light and sound. This, of course, is true when we desire to obtain cerebral rest for our patient. When spinal rest is the object sought after, the chief point is, of course, the avoidance of those tactile impressions which evoke reflex response on the part of the cord (the consciousness or unconsciousness of the patient being a matter of entirely subsidiary importance). When an individual is secluded in an isolated and perfectly dark room, it is evident that those impressions of light and sound which ordinarily attend and usher in consciousness are entirely eliminated, so that the brain, if previously predisposed to tranquillity by the means to which we have already had occasion to refer, may be maintained in a state of quiescence for a period of far greater duration than is possible under ordinary circumstances. It is surprising, indeed, to what an extent sleep may be prolonged under these conditions, especially when, to the other means of perpetuating unconsciousness at our disposal, is added

the subtle force of carefully and progressively cultivated habit. Nothing can exceed the astonishment of persons who have submitted to this scheme of rest when told of the number of hours which they have passed in a state of unconsciousness. It is true that after thus oversleeping there is, in the beginning, some little mental inertia,—some difficulty in "getting thoroughly awake;" but this is soon dissipated by the aid of a mild sponge- or shower-bath, followed by vigorous friction, or by a moderate dose of caffeine.

It now remains to say a word respecting the manner in which the patient is to occupy himself during the period of wakefulness which succeeds the interval of unconscious rest. In the severer cases of cerebral irritation, melancholia, and exhaustion, in the treatment of which I employ rest, I am in the habit of absolutely prohibiting both reading and writing. Any occupation, in fact, which causes undue concentration of the intellectual faculties, or which arouses unpleasant emotions, or which predisposes to morbid brooding, is to be avoided. A chronic habit of introspection is one of the most disagreeable features with which we are called to contend when it is a question of affording prolonged rest to the sensorium.

Otherwise to be considered are those amusements

which, while diverting the mind from self-consuming reflections, do not materially exhaust its energies. Gay music, hilarious theatrical representations,—these are potent remedies against the insidious inroads upon the tranquillity of the mind born of chronic introspection and inordinate worry. It matters, indeed, little what the character of the amusement be so long as indulgence in the same is not coupled with late hours,—a characteristic which, unfortunately, is inseparable from many recreations indulged in by the inhabitants of cities.

The matter of food has already been alluded to, in so far as the important group of soporific aliments is concerned. There are, however, other foods of importance to a rational system of cerebral rest,—I mean those nitrogenous compounds which are indispensable to brain and muscle alike. I have already had occasion to point out that experimental inquiry has shown that mental work involves the consumption of both the nitrates and phosphates, and that these observations are supported by direct analysis of the chemical constitution of the brain itself, so far as such have been attempted.[1]

[1] The experiments here referred to are those of Byasson, quoted in my monograph on Brain-Exhaustion, D. Appleton & Co., New York, 1884, p. 41 *et seq.*

While, therefore, it is impossible with the present means at our command to elucidate the more intimate chemistry of cerebral metamorphosis, we are clearly justified in inferring that the introduction and assimilation of nitrogenous and phosphatic compounds is of importance in exhaustive conditions of the cerebral ganglia. In entire consonance with these views is the observation that the amount of phosphorus contained in the brain is greatest among those of active intellects, and that it increases in amount with the growth of the individual, attaining the maximum quantity at the period of adult life. In the aged, on the other hand, the quantity is considerably reduced; and it has also been alleged that among idiots the amount of phosphorus contained in the brain is much below the normal standard (?).

It is not surprising, therefore, that the flesh of animals (or its extracts), eggs, milk, and unbolted cereals are the aliments which experience has proven to be of the greatest value where a direct augmentation of cerebral nutrition is the object sought. To these foods may also be added cod-liver oil or its preparations, where the fatty tissues are imperfectly developed. Should the condition of the digestive mechanism preclude the introduction of oils by the way of the stomach, they may

be injected hypodermically, in doses of from one to four drachms; and, in exceptional cases, the quantity injected at one time may be increased beyond half an ounce, provided the skin is sufficiently loose to preclude the occurrence of painful tension. The injection should, therefore, usually be accomplished slowly; and, in order to avoid the needless detention of the physician by the operation, I have devised an apparatus which accomplishes this injection automatically, the supervision of the same being intrusted to the patient himself.

In cases of profound disturbance of the digestive organs there should, of course, be no hesitancy in resorting to systematic alimentation per rectum, a procedure which may be combined advantageously with hypodermic injection of oil.

This, then, is a brief outline of the system of cerebral rest to which I have resorted in the treatment of a large class of functional cerebral derangements during the last few years. Of the success attending this mode of treatment I will speak in guarded terms, lest I should develop a degree of enthusiasm which to some might appear inordinate. This much I will say, however, that I have employed it in the treatment of cerebral irritability and exhaustion and in cases of insomnia which had resisted all ordinary remedies. I have also had

recourse to it in the treatment of chorea and the first stages of melancholia.

It would be a conspicuous omission did we fail, in concluding this chapter, to give an account of the special precautions to be observed in the management of the condition of melancholy which is often so serious a complication of severe pain. While, as previously shown, it is of the greatest importance that those who suffer from profound depression should be made to sleep,—for only in this way can the emotional stress be adequately compensated,—it is equally incumbent upon us to diminish, as far as possible, the mental pain from which such persons suffer during the hours of wakefulness. Indeed, it may as well be stated at once that our efforts to procure sleep for the patient are almost certain to result in failure, unless we succeed in abolishing or, at least, relieving his melancholy as the time set apart for unconscious rest approaches.

Should there be marked physical pain it must, of course, be removed by the application of one or several of the expedients to be subsequently discussed. Such relief will of itself tend to facilitate the occurrence of sleep. Sometimes, however, in spite of the exemption from acute physical suffering, the mental pain—the melancholia—still persists.

This is especially true of those who have borne the brunt of a long and painful illness. Under such circumstances nothing in the world is comparable in efficacy with the judicious use of stimulants while the subject remains in a condensed atmosphere, by which we mean air which is compressed until it is at least twice as dense as the normal atmosphere. The object of this exposure of the patient to a condensed atmosphere is to augment the action of the previously-administered stimulants and to promote the circulation in the cerebro-spinal axis, for it is a matter of experience, as I long since showed by the statistics of the populations whose vocations necessitate a prolonged sojourn in compressed air, that these remedies, especially those of a diffusible character, are materially re-enforced in their effects when thus exhibited.

The stimulants which are best suited to this mode of administration are absinthe, caffeine, and alcohol. Although ether might perhaps be added to the list, I have purposely omitted it, since, though its stimulating properties are greatly enhanced by the immersion of the patient in compressed air, the exhilaration thus evoked is too evanescent, and is, moreover, speedily followed by increased irritability and depression. This criticism applies neither to alcohol, caffeine, nor absinthe, when medicinally

employed, by which we understand that the patient should not be informed of the nature of the remedies, and that the latter should be continued no longer than seems absolutely necessary, their gradual withdrawal being undertaken as soon as there is a return of appetite and normal sleep.

Another extremely important measure in the management of melancholia is the stimulation of the excretory functions. To this end a sufficient cathartic should be given to insure at least one operation of the bowels a day; for nothing is more certain than that constipation is of itself quite capable of provoking and perpetuating a state of mental depression.

The action of the kidneys, too, should be increased by the administration of appropriate diuretics, the substance known as diuretin being one of the best.

Finally, it is of very great importance to augment the excretory functions of the skin; for numerous observations have shown that in this way foreign materials which exert a depressant action upon the central nervous system may, in part at least, be eliminated.

To thoroughly appreciate the importance of these injunctions, it must be remembered that in melancholia all the vital processes are more or less cur-

tailed, as revealed by the loss of weight, as well as by the inertia of the affective and intellectual faculties. We have, in a word, to do with a predominance of the processes of waste over those of integration, with a defective metabolism of which the final effect must be the inordinate accumulation of waste products in the organism.

No physician of large practical experience in the management of this class of cases will, I believe, be inclined to question this exposition of the pathology of melancholia. Nor will the conclusion that the elimination of these waste products must be thoroughly accomplished—must proceed, indeed, side by side with our attempts to build up the devitalized tissues by the aid of appropriate nutrition—be gainsaid.

And let me observe, parenthetically, that the effects of some diuretics and diaphoretics, and perhaps of all, are notably enhanced by their exhibition while the patient remains under a pressure of two atmospheres. This fact will be readily understood when it is remembered that one of the chief effects of compressed air, when used in this way, is to increase the blood-pressure in the interior of the organism, the blood being driven from the periphery towards the centre. The effect of this is, of course, to increase the action of those nervous mechanisms

which control the secretory and excretory functions, and also to raise the blood-pressure in the organs themselves and, notably, in the kidneys and liver.

In a subsequent chapter the various physiological and clinical data connected with the employment of compressed air in the treatment of melancholia and pain, notably that of intracranial origin, will be discussed in full, so that, having anticipated enough in the present chapter to render the argument intelligible, we must beg permission to leave the subject for the present, avoiding thereby needless repetition.

Finally, the good effects sometimes obtainable from the use of moderately cold shower-baths are not to be ignored. It must not be forgotten, however, that this mode of treatment is admissible only when the condition of the heart and circulation is such as to insure a proper reaction,—*i.e.*, increased redness of the lips and skin, a diminution of the feeling of malaise, accelerated heart-beat, and at least a temporary disappearance of apathy.

It need hardly be added that the diversion of the patient, in every possible manner, and his eventual exposure to changes of scene and climate,—but the latter only after he has proceeded well along the road to recovery,—are things which render valuable assistance in confirming the good work accomplished by more direct measures.

CHAPTER XI.

OF INTERNAL REMEDIES WHICH ARE EITHER DIRECTLY OR INDIRECTLY APPLICABLE IN THE TREATMENT OF PAIN.

From what has previously been said regarding the causation and collateral phenomena of pain, it is evident that the remedies which are applicable in its management are manifold. They include, in the first place, a large number of substances broadly and somewhat roughly classified as nervous sedatives and stimulants; secondly, a somewhat smaller category of analgesics which are, strictly speaking, perhaps neither sedatives nor tonics; and, thirdly, chemicals which are supposed to effect more or less profound changes in the morphological process,—the so-called alteratives.

It will be well to bestow a glance upon the more important of these remedies.

Nervous Sedatives.—In this category belong those agents which exert a depressing effect upon the cerebro-spinal axis, the brain being often that portion of the nervous system most obviously affected. Narcotic substances are representative of this class of remedies.

Opium and its derivatives constitute, in some respects, the most important remedies which we possess for combating painful paroxysms of great severity. Physiologists are by no means agreed as to the manner in which opium exercises its effects upon the organism. Thus, some writers of distinction assert that it is a sedative pure and simple, while others insist that it is to be regarded as a stimulant. The truth of the matter is, however, that its action may be both sedative and stimulant, the diversity of physiological effect being in great measure contingent upon the difference in the magnitude of the dose. Thus, small doses are productive in most instances of marked stimulating effects, whereas large ones are sedative in their action.

The hypnotic property of opium has been ascribed by some to its influence in lessening the amount of blood in the brain; but, for my own part, while fully recognizing the importance of the circulatory phenomena induced, I cannot forbear the conviction that the latter are of purely secondary origin, being in the main attributable to the primary action of the drug upon the substance of the brain. This ability of the drug to retard cerebral metabolism is the essential feature of hypnosis.

It would transcend the limits and objects of the present work were I to enter into a discussion of

the various conflicting opinions which have been advanced from time to time as the result of extensive experimentation. Much of the discrepancy in the nature of these results is doubtless attributable to variation in the size of the dose, as well as to fluctuation in the quantity of the very numerous active principles contained in the drug. No less than nineteen different alkaloids have been separated from this exceedingly complex substance, so that, in introducing the crude drug into the system, we necessarily have to do with an aggregate effect of all of them. In their relative therapeutic value, however, the alkaloids of opium differ widely; but, if extensive applicability as an analgesic be a criterion of excellence, pre-eminence must unquestionably be ascribed to morphine.

The stimulating effects of morphine upon the circulation and central nervous system are not as pronounced as those of opium, and its soporific influence is also less positive. The anodyne effects of opium and morphine are so thoroughly understood as to render even a reference to them almost superfluous in a work of this kind. We are, however, too liable to forget that previous to the introduction of chloral, the bromides, and the coal-tar derivatives, opium occupied the highest position in the treatment of all forms of insomnia, and that

even at the present day, in spite of the great progress made in pharmacy, the poppy may sometimes be invoked as a soporific medicine. When combined with one or more of the modern remedies, such as chloral, the bromide of potash, and hyoscyamus, the result is a preparation possessing unique virtues in the management of certain cases of insomnia.

Where there is severe pain, as in tic douloureux and other aggravated forms of neuralgia, preference should, of course, be given to morphine, administered in conjunction with atropine,—one-hundredth of a grain of atropine to a quarter of a grain of morphine. In the delirium of fevers and mania, in insomnia preceding various forms of insanity, as well as in the wakefulness due to the various acute and chronic diseases, morphine often renders invaluable assistance.

In spite of the extensive abuse in the use of alcohol, which has become such a crying evil of modern social life, it must be admitted that this is a most useful remedy in the management of a large number of painful conditions associated with anæmia. For this reason a knowledge of its more obvious physiological effects is essential to its intelligent employment.

When used in moderation, alcohol is absorbed by

the tissues with benefit, contributing in a certain degree to the nutrition of the latter, and causing a sensation of exhilaration. The effects produced by its excessive use are, however, quite different.

Under these circumstances the normal chemistry of the tissues is profoundly deranged; their functions are interfered with; and, as an ultimate result, the characteristic phenomena of starvation become established. The functions of the nervous system which are disturbed by the presence of an excessive amount of alcohol in the blood and tissues are those of voluntary motion, reflex action, and sensation. Small doses of alcohol produce more or less stimulation of the cerebro-spinal functions, and, as a consequence, moderately painful sensations, especially those of intracranial origin, are speedily relieved. The secretory functions, too, are exalted, as shown by increased secretion of saliva and perspiration. The heart-beat is also increased in frequency, and the skin, especially about the head, becomes suffused with blood. Respiration is also more or less accelerated; the eyes glisten because of the increased lachrymal secretion, and the pupils are slightly contracted. In consequence of the general nervous exaltation the individuals desire to move about, and even to dance and run. For a time there is considerable hyperæsthesia of the special senses; the

acuity of perception is increased; ideation is more vivid; and, in a word, all the intellectual faculties are exalted. As may readily be imagined, the emotions participate in the general exhilaration; immoderate laughter is engendered upon the slightest provocation, and the dominant psychical peculiarities of the individual become conspicuous. At the same time the reasoning faculties lose their restraining influence, and the inhibitory effects of conscience and experience are thrown to the winds. These are the typical manifestations engendered by moderate doses of alcohol, subject, of course, to temperamental variations. When, however, the amount ingested is large, the primary exaltation gives place in a short time to all the symptoms of depression; co-ordination is impaired; the gait becomes uncertain; articulation is interfered with; and ideation becomes confused and incoherent. At length sensation and motion become impossible, consciousness is suspended, and the patient lies in a state which is practically comatose.

Though at first sight the physiological explanation of such heterogeneous symptoms impresses one as little short of impossible, a more careful analysis shows that they can all be traced to the inhibitory or paralyzing action of alcohol, when present in animal and vegetable protoplasm.

The action of alcohol upon the circulation is a matter of profound practical interest from a therapeutic point of view; and this is especially exemplified by functional affections of the nervous system, in which the condition of the vaso-motor system is often a factor of some importance. Without entering into the intricacies of the subject, it may be stated in general terms that the first effect of alcohol upon the circulation is to cause increased arterial pressure: the muscular coats of the arteries are contracted, and the diameter of the vessels consequently reduced. These primary effects are, however, of brief duration, for in a short time the increase in arterial pressure is followed by a corresponding decrease; the relaxation of the vessels becomes universal, and, at the same time, the energy of cardiac action is diminished. These phenomena are in themselves of the greatest importance, and their interest to the neurologist is enhanced from the fact that the circulation of the cord and brain —particularly the latter—is pre-eminently affected.

The hyperæmic condition evoked by alcohol is evidently due to the paralyzing action of this agent upon the terminal (peripheral) apparatus of the vaso-motor nerves. This terminal apparatus, as is well known, is situated in the walls of the vessels themselves.

It is evident from the foregoing data regarding its physiological effects that alcohol possesses peculiar advantages in the treatment of a variety of painful intracranial conditions characterized by the presence of more or less anæmia. The insomnia, too, which so frequently accompanies general anæmia, is readily relieved by its administration in moderate doses. When, however, the relief of severe neuralgia is in question, large doses alone are applicable, as may readily be deduced from what has previously been said. This question of correct dosage has indeed given rise to much controversy, as is abundantly shown by the discrepancies of opinion prevalent in current literature and the special treatises on therapeutics. While it is difficult to enunciate rules which shall cover the exigencies arising in all cases, it may be stated in general terms that where stimulating effects are required moderate doses (from four to five drachms of spirits), repeated at regular intervals, are indicated. On the other hand, when the principal object of treatment is to cause relaxation of the cerebral blood-vessels, the doses should be full. It is impossible, however, to lay down infallible rules of exhibition on account of the variable susceptibility of different persons, and hence the symptoms of the patient should be studied and the quantity

increased until there is well-marked throbbing of the carotids and flushing of the face and conjunctivæ.

Inhalation of ether is sometimes employed to mitigate the atrocious pain of *tic douloureux*. Its effects are, however, evanescent in character, owing to the rapidity with which this agent is eliminated from the system through the lungs, and hence the expedient can never replace remedies introduced into the system in solution, and which, owing to their gradual elimination from the organism, exert an analgesic influence for relatively long periods of time. These objections do not apply to the same extent to the internal administration of ether in the form of Hoffmann's anodyne, which is a mixture of alcohol, ether, and ethereal oil. This preparation may be exhibited in doses of from one-half to one drachm, to be repeated every half-hour or oftener, till physiological effects are obtained. The same objections which apply to inhalations of ether hold good in the case of chloroform, and hence by far the most serviceable mode of administration is in the form of chlorodyne, a preparation which has long held a deservedly high place in the esteem of the profession, both in this country and England, where it was first introduced by Dr. Browne.

Among the general nervous sedatives the bromides occupy a deservedly high place. It must be confessed, however, that while they are capable of relieving minor grades of intracranial pain, due to passive engorgement, their analgesic powers are not sufficient to cope with even moderately severe peripheral neuralgia. Still, they render a certain amount of assistance in the management of nervous irritability and other collateral effects of pain. The physician should, therefore, be equipped with a general knowledge of their physiological effects in order to employ them intelligently.

The bromide of potassium is, strictly speaking, a general nervous sedative rather than an hypnotic; and consequently it may be employed with advantage in allaying irritability of the brain, spinal cord, and sexual system. In this way it may indirectly induce sleep.[1] Of this something more will be said hereafter.

It seems clear, indeed, that the bromide of potassium exerts its sedative action in a twofold manner: 1, by causing a diminution in the intensity of the vital processes of the ganglia; and, 2, by causing more or less retrocession of the intracranial blood.

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[1] On the Action of Medicines in the System, by Frederick William Headland, M.D., Philadelphia, 1878.

Even the most superficial knowledge of cerebral physiology will serve to exhibit the importance of a remedy which combines two such valuable qualities. The potency of the bromides in the treatment of epilepsy and other irritable and explosive conditions of the nervous system is undoubtedly attributable to this duality of effect.

The soporific energy of the bromides may be ranked, approximately, as follows:

Bromide of potassium first, bromide of lithium second, and bromide of sodium third.

It is clear, then, from their action, that the bromides find their chief application in irritable explosive and exhaustive conditions of the central nervous system. They have also been largely employed in the treatment of insomnia due to worry and morbid emotionality. I am convinced, however, that we should exercise caution when thus resorting to them, in order to avoid the depression which follows a too copious administration.

The insomnia of sexual excitement, of mania, of hysteria, of cerebral exhaustion and cerebral irritability, may be combated effectively by the administration of the bromides in conjunction with hypnotics. It is necessary to bear in mind, however, that the bromides should be given repeatedly during the day, beginning in the afternoon at two

o'clock and continuing the dose every hour until shortly before retiring. We may then supplement the sedative action of the bromides by a moderate dose of some hypnotic, such as trional or chloralamid. In persons who suffer from general and local anæmia it may happen that, instead of promoting sleep, the bromides serve only to augment the insomnia. Under these circumstances alcohol should be given in quantities sufficient to cause slight flushing of the face. Should these measures prove ineffectual, ten to twenty drops of the tincture of opium may be added, or the tincture of hyoscyamus (two drachms) with chloral (fifteen grains). The dose of the bromides which is required to produce the characteristic sedative effect varies much more than is commonly supposed. Thus, cases are seen in which ten grains of the potassium salt were sufficient to produce drowsiness. Such cases must, however, be regarded as somewhat exceptional, since in most subjects scruple doses of the lithium and potassium salts may be repeated every hour or two until hebetude is pronounced. When a rapid sedative effect is required the dose may be increased to thirty, forty, or sixty grains; and this applies to the sodium and calcium salts as well as to the bromides of lithium and potassium.

Hydrobromic acid has also been employed to

some extent as an hypnotic, in doses of from twenty to thirty grains, diluted with a sweet, aqueous vehicle of some kind. On account of its offensive taste, however, it is not a preparation which is destined to occupy a place of much importance.

Gelsemium was formerly considerably employed in the treatment of pain, but of late, since the introduction of the coal-tar derivatives, its use has been much restricted. The extremely poisonous effects of the plant, which make their appearance suddenly, and often without ascertainable cause, have had much to do with this.

Nervous Stimulants.—It now remains to consider briefly those substances which exert a demonstrably stimulating effect upon the central nervous apparatus. As is well known, some of these agents may be both sedative and stimulating in their action, according to the size of the dose and other circumstances of administration. This duality of effect is particularly exemplified in the case of opium, as we have already had occasion to observe when considering the sedative properties of that drug. Although we are most frequently called upon to invoke the sedative property of the drug in the management of painful conditions, it must nevertheless be conceded that under some circumstances its stimulating properties are capable of

rendering substantial assistance. This is especially true of pain which is associated with well-marked debility; for, as has already been pointed out, the nervous system—though, perhaps, the last to share the impairment consequent upon such malnutrition—ultimately suffers with the rest of the organism, and hence measures specially directed to the rehabilitation of its functions are indicated.

Cannabis Indica is a remedy of the same order, its effects being conspicuously exerted upon the central perceptive mechanism, which is stimulated, perverted, or exaggerated in various ways, according to individual susceptibility. In most persons its most obvious effect is an agreeable intoxication. The mental faculties are exalted; the subject laughs in an inordinate, hysterical manner, and becomes unusually loquacious; while the countenance wears a beatific expression, indicative of the satisfaction which reigns within. The flow of ideas is stimulated to an inordinate degree, and as a consequence the thoughts are disconnected and wholly irrelevant, as indicated by rapid and incoherent utterances. Sometimes surrounding objects—such as articles of furniture—assume unusual shapes, and thus veritable illusions are developed. Sometimes the sexual functions are excited, and the gestures, facial expression, and conversation are of the most libidi-

nous character. Sensibility may also be affected; and there may be sensations of numbness and pricking in the soles of the feet, accompanied, in some instances, by burning, when pressure is applied to the integument. Sometimes, too, there may be anæsthesia of such intensity as materially to interfere with all attempts at locomotion, the subject, while standing, being totally unconscious of the presence of his feet upon the ground. It may readily be imagined that an agent which possesses such qualities is capable of rendering substantial assistance in the management of pain. And, indeed, experience has shown that, when it is administered in sufficient quantities to produce these phenomena, a variety of painful conditions, and, notably, certain headaches, may be ameliorated and sometimes permanently abolished. When, however, its administration is still further increased, sleep may be produced, but a sleep so far removed from the normal prototype, accompanied as it is by delirium and morbid cerebral erethism, that its exhibition in this manner is not usually to be commended. But it is a noteworthy circumstance that its usefulness is appreciably enhanced by combination with opium, belladonna, or hyoscyamus, and when thus administered its effects are often most happy, since it promotes the tolerance of the sys-

tem to opiates, and probably supplements their action. Cannabis Indica, then, has a wide range of applicability in the management not only of pain, but of the collateral nervous disturbances of that condition as well. Thus, it has been employed in the different varieties of insomnia, neuralgia, headache (migraine), and convulsions. In headaches of a local character, accompanied by sensations of throbbing and lachrymation, it has been highly spoken of by Ringer, and I have frequently had occasion to verify its efficacy in this connection. It must be remembered, however, that all persons are by no means affected in an identical manner; and, consequently, too much should not be anticipated from its employment on purely *a priori* grounds. Race, climate, and constitutional idiosyncrasy have all been cited from time to time as affording the true explanation of this inconstancy of action; but it must be conceded that such theories are not altogether explanatory. In the face of such discrepancy, then, empiricism is our best guide; and the use or abandonment of the drug in a given case may safely be decided by the results obtained by careful trial. As all practitioners are aware, the large and variegated group of symptoms included under the name of hysteria are often relieved by the administration of valerian.

Ringer has found it useful in relieving hot and cold perspiration, flushing of the face, and the restlessness and mental depression so often found among neurotic persons. As an antispasmodic it has also been used in chorea and whooping-cough, and occasionally mild neuralgia has been relieved by it. It must be confessed, however, that its effects upon pain are slight, and not to be relied upon.

Belladonna has long been employed in neurological medicine in the most diverse conditions. Owing to a lack of comprehension of its somewhat complicated physiological effects it has also been much abused; and I believe, therefore, that it will not be time misspent if we examine somewhat in detail the knowledge of its action, which has been gained by most elaborate experimental investigation.

Belladonna or its alkaloid, atropine, when introduced into the system subcutaneously or by the mouth, increases the irritability of the gray substance of the spinal cord. This influence is especially pronounced in the domain of the vaso-motor centre, and respiration as well as the action of the heart is appreciably increased. It has been found, however, that belladonna does not act in the same manner upon the heart of the dog as upon that of man. According to some observers the pulsations of the heart in frogs are not increased after the

administration of this substance; neither is there any appreciable dilatation of the pupil. After considerable doses of belladonna there is marked diminution of muscular power; this effect is particularly manifest in the gait, which becomes uncertain and staggering. So great may this weakness become that the subject is absolutely unable to direct his movements, and staggers about like a person laboring under the influence of alcoholic intoxication. When the amount of the drug absorbed by the system is sufficiently large, these phenomena may develop into complete paralysis. The muscles of the trunk are first affected; then the terminations of the pneumogastric in the heart and lungs become implicated; and, finally, the endings of the secretory nerves of the salivary and sweat glands and the terminations of the nerves supplying the iris are involved.

Flushing of the face, dryness of the mouth, tongue, pharynx, and larynx, dilatation of the pupil, and a certain bright appearance about the eyes are among the more obvious phenomena evoked by full doses of belladonna.

The effects produced upon the mental faculties are often grotesque, and at times alarming. Sometimes the subject labors under the influence of extreme restlessness. He wanders about, paces to and fro in a nervous, excitable condition; and, in a word, he is

impelled to keep constantly moving, in spite of a strenuous desire to remain quiet. At the same time the intellectual faculties keep pace with the motor excitement; ideas come and go with great rapidity, but are at first connected,—a quality which they afterwards lose. Sometimes, too, the movements of the patient appear to be governed by a species of automatism which induces the constant repetition of the same gesture. These movements savor often of the trade or occupation of the patient. Thus, I know of a shoemaker who, under the influence of large doses of belladonna, executed with great precision the movements peculiar to his calling, a process which was sometimes continued for an hour or more.

The exalted condition of the mental faculties is progressively increased; the rapidly evolved but previously connected ideas become more and more incoherent, and gradually give place to hallucinations and a condition of delirium—sometimes characterized by acts of violence—necessitating the employment of restraint.

Sometimes mental disturbances of this character may result from comparatively insignificant doses; so that too much care cannot be exercised in order to ascertain the susceptibility of the subject. Pain in the head—over the forehead or in the eyes—is a frequently observed symptom after moderate doses;

and tinnitus may accompany it, giving rise to the opinion on the part of the patient that he is under the influence of quinine. A scarlet rash about the joints has sometimes been observed after poisoning by belladonna; but this symptom is not very characteristic.

To give all the therapeutic indications of belladonna would exceed the objects and scope of the present work; I shall, therefore, only refer to the more important applications of the drug.

Aside from its usefulness in the treatment of epilepsy and profuse perspiration, which possess less interest for us, belladonna has been employed to check the paroxysms of whooping-cough, urinary incontinence, and chronic inflammation of the spinal cord. Brown-Séquard is its chief exponent in the last-named connection, basing his advocacy on the belief that it causes contraction of the small vessels of the cord. Belladonna has long been used in the treatment of a wide range of painful affections, and, notably, in combination with morphine and codeine.

The paroxysms of asthma, too, are often arrested by belladonna. It must be confessed, however, that many instances are recorded in medical literature in which belladonna has failed to afford the results anticipated from it, chiefly because it was given in too small doses. As Ringer long since observed, it

may be necessary to give as much as ten minims of the tincture every two or three hours, in order to allay the discomfort of chronic asthmatics.

The physiological effects of stramonium are quite similar to those of belladonna, and, like the latter, it has been much employed in bronchial spasms and nervous asthma. It is not directly soporific in its action, but, when employed as above indicated, it promotes sleep indirectly, by allaying irritative symptoms which prevent unconsciousness. As is well known, the effects of the drug are best obtained by smoking.

Fifteen or twenty grains of the dried leaves, or ten of the powdered dried root, are placed in an ordinary pipe, and the smoke is slowly inhaled. The addition of tobacco has been suggested; but only persons thoroughly habituated to the use of the drug are able to inhale the latter without great discomfort. This is especially true of children and delicate women, who are frequently thrown into violent paroxysms by crude attempts of this kind. Some of the medicated pastilles found in the shops may occasionally serve as substitutes for the dried leaves; the practice of mixing the latter with saltpetre and allowing them to be slowly consumed while the fumes are inhaled is a time-honored expedient, but decidedly inferior to smoking.

Strychnine is a remedy which has long been used in the treatment of various atonic conditions of the spinal cord. From this it may be readily inferred that its effects manifest themselves principally in the domain of this structure, the irritability of the cord being increased by its administration. When a large quantity of the remedy is introduced into the system symptoms which bear the closest resemblance to those of tetanus are evoked. These phenomena are exhaustively discussed in the systematic treatises, so that nothing further need be said of them.

Strychnine is especially useful in the treatment of spinal irritation and other painful conditions due to nutritive derangements of the cord.

Calabar bean and its alkaloid, physostigmine, are opposed in their action to that of strychnine, and hence they may be employed with good effect in case of poisoning by that drug, as well as in tetanic spasms from other causes. In all cases of pain, therefore, where it is desirable for any reason to diminish the irritability of the cord, physostigmine may confidently be exhibited.

The physiological effects of physostigmine have been most thoroughly investigated by Dr. Fraser. Did the scope of this work permit I should be glad to quote these experiments in full, but, on account

of the limited space available, I shall be obliged to summarize them briefly, as follows:

When physostigmine is introduced into the system it gradually diminishes and finally destroys the irritability of the gray substance of the spinal cord. It also causes a diminution of the number of the heart's contractions when given in moderately large doses; and when the amount of the substance introduced into the system is considerable cardiac action is almost immediately arrested. Large doses of physostigmine also cause paralysis of respiration.

If, after introduction of the poison into the system, the galvanic current be applied to the vagus, it will be found that a weaker current is required to arrest the action of the heart than when the animal is in health.

From what has been said it is evident that Calabar bean is rather a sedative than a stimulant; but I have referred to it in this place because of its antagonistic action to that of strychnine.

Quinine, phosphorus, zinc, and arsenic are among the valuable tonics which have been employed in the treatment of a large number of painful conditions characterized by marked debility of the nervous system. Quinine is especially useful in the treatment of those painful conditions due to malarial influences. This is well exemplified in its rapid

curative action in supraorbital neuralgia due to malaria. There are, however, besides these brow-pains, others which do not yield to even the largest doses of quinine, a fact which has not been sufficiently accentuated in the books.

By promoting metamorphosis in the tissues phosphorus increases the intensity of the vital processes, and much of the benefit incident to its administration is doubtless due to this fact. It must not be forgotten, however, that if such benefits are to be permanently realized the general nutrition must be augmented to such a degree as to compensate for the destructive changes in the tissues which are inevitable when phosphorus is present in considerable quantities in the organism.

Though the manner in which zinc exercises its effects is less obvious, its use in the clinic has shown it to be of very considerable value as a tonic. This is especially shown by its almost specific effects in many cases of chorea.

Arsenic, too, has likewise been employed in the treatment of a number of painful affections of peripheral origin, and notably in sciatica and in the ambulatory pains sometimes encountered in choreic children. Its specific effects upon the irregular movements of St. Vitus's dance are too well known to the profession to require more than cursory mention.

CHAPTER XII.

OF OTHER AND MORE RECENT REMEDIES WHICH HAVE BEEN EMPLOYED IN THE TREATMENT OF PAIN.

During the past few years a number of new substances have been added to organic chemistry, some of which have certainly proved themselves to be of great value in the treatment of pain. Some of these bodies have been obtained directly from coal-tar, and hence they are known in the shops as the coal-tar derivatives. Others, again, are the reward of only the most elaborate and ingenious synthesis. It is not a matter of surprise that the Teutonic mind, with its resourceful vigor and tenacity of purpose, should have been chiefly instrumental in giving us these new and valuable remedies.

Obviously, a short *résumé* of the salient characteristics of the more important of these new analgesics is indispensable to completeness of statement.

Antipyrin, first produced by Knorr, of Erlangen, is an antipyretic and analgesic of very great value. It has a number of scientific designations, of which *dimethyloxyquinizin* is the least polysyllabic. Anti-

pyrin is soluble in water and chloroform, less so in ether. On account of its depressant influence on the heart's action it is best given in half a tumbler of water to which a teaspoonful of the aromatic spirit of ammonia has been added.

As a rule, doses of from ten to thirty grains will be found sufficient.

Antipyrin is one of the most universally applicable analgesics which we possess. It has been employed with success in the various forms of neuralgia, spinal irritation, headache, and tubercular meningitis. In the last-named affection I have injected it, in combination with cocaine, directly into the spinal canal. For the technical points involved in the last-named procedure see the subsequent chapter on local medication of the cord. Even the pains of locomotor ataxia, labor, and those of cancer and dysmenorrhœa have been relieved by it. When given hypodermically it acts much more rapidly, and hence its exhibition in this way has been recommended in angina pectoris, renal and biliary colic, and dysmenorrhœa.

Phenacetin, like antipyrin, is a derivative of coal-tar. It is likewise known in the technical literature of chemistry as *acetophenetidin*. Phenacetin is sparingly soluble in cold water, somewhat more so in boiling water, and quite soluble in alcohol. It

is, perhaps, best given in cachets, in doses of from ten to fifteen grains.

Though inferior to antipyrin in rapidity and certainty of effect, phenacetin is, nevertheless, an analgesic and antipyretic possessed of special advantages. In the first place, it has, in addition to its anodyne qualities, a sedative and soporific action, which is often most useful where we have to deal with pain accompanied by marked restlessness and extreme irritability. In such cases the mere removal of the pain is not always sufficient to induce sleep, though, of course, a desideratum of the first importance. Consequently, a supplementary soporific action is required, and this, in the case of phenacetin, is afforded by the drug itself; whereas the same cannot be said of antipyrin, the administration of which, while usually followed by relief from pain, is more likely to engender wakefulness than sleep.

Phenacetin has been extensively employed as an analgesic in the milder kinds of neuralgia and migraine; and it has also rendered good service in the treatment of pain of rheumatic origin. In the last-named affection it has been advantageously combined with salol in tablets, which have obtained a wide currency, and are now probably well known to all practitioners.

Exalgin is closely allied in its structure to acetanilid. It is, in fact, *methyl-acetanilid*, a compound resulting from the interaction of monomethyl-anilid and acetyl chloride. Though quite soluble in alcohol it is only sparingly so in water, and hence it is usually given in cachets, in doses of from two to six grains.

As an analgesic, antipyretic, and antiseptic, exalgin has obtained some reputation, chiefly because its administration is devoid of such unpleasant symptoms as irritation and rash. It must be admitted, however, that when the dose is carried beyond the bounds of prudence, trembling and even paralysis of respiration may be induced.

Salol is the *phenyl ether of salicylic acid*, or, to express it more simply, it is the salicylate of phenyl.

The white, crystalline appearance of this substance is doubtless familiar to the majority of physicians.

Though insoluble in water, salol dissolves without difficulty in alcohol, the fixed oils, and ether. It is best given in milk or cachets. The dose is from five to thirty grains.

A noteworthy circumstance in connection with its exhibition is the fact that it passes unaltered through the stomach,—so that digestion is unaffected by it,—and only becomes split up into its

phenyl and salicyl elements in the duodenum by the action of the pancreatic juice. Both alone and in combination with phenacetin it has been employed as an analgesic; but its chief field of usefulness is acute rheumatism, where it frequently acts with remarkable promptness.

Besides many pains of rheumatic origin, which are promptly relieved by the administration of salol, neuralgia of the eyeball and even earache have been subdued by it.

Salipyrin, as its name implies, is a chemical combination of salicylic acid and antipyrin. It is a white, crystalline substance, little or not at all soluble in water, but dissolving readily in alcohol, and may be exhibited in doses of from fifteen to thirty grains. In my opinion, not more than seventy-five grains should be given in the course of twenty-four hours. From its composition the conclusion is almost inevitable that salipyrin must be a useful remedy in a large category of painful affections, among which those of rheumatic origin are not the least. What I have been able to ascertain of its efficiency by trial in the clinic has convinced me that these conclusions are fully justified. In fact, salipyrin seems to possess a unique value as a means of combating those ambulatory pains whose origin is often so obscure, but whose capacity for engender-

ing distress in the patient and annoyance in the physician is so positive.

These observations are especially applicable in the case of that protean distemper, the "grippe" (influenza), the pains of which are readily controlled by the administration of salipyrin, in doses of twenty grains every three or four hours.

When giving it in this way it is well to counteract its depressing effect on the heart's action by the simultaneous exhibition of a heart tonic. I usually employ for the purpose a tablet of strychnine, sparteine, and digitalis.

Salophen contains over fifty per cent. of salicylic acid; and its efficacy in rheumatic affections, and especially in acute rheumatic arthritis, is doubtless attributable to this fact. The small, white crystals in which it occurs are quite soluble in ether and alcohol. As a rule, from ten to fifteen grains are a sufficient dose, and the daily maximum amount should not greatly exceed sixty or seventy grains.

Solanine is a glucoside derived from the *Solanum nigrum* and other Solanaceæ. The crystalline powder in which it occurs is practically insoluble in water, but dissolves in hot alcohol. As an analgesic solanine has been highly praised by some authors, having on several occasions afforded prompt relief in neuralgia of considerable severity.

The dose of the glucoside is from one-fifth to one grain, and may be exhibited either in tablet form or as a powder.

Where hypodermic administration is desirable the hydrochloride should be employed in like doses.

Thymacetin is a derivative of thymol, and is nearly related to phenacetin, which it also resembles quite closely in its physiological action. Occurring as a white, crystalline powder, it has been used, in doses of from four to fifteen grains, as an analgesic and hypnotic. Doses of from eight to ten grains are usually sufficient to cause drowsiness.

Urethane, a carbonate of ethylic ether, occurs in colorless, prismatic crystals, is soluble in diluted alcohol, and is used principally as a hypnotic and as an antagonist to the convulsions of tetanus. In the last-named rôle it is said to be decidedly more potent than chloral. Its analgesic properties are, however, quite subordinate to its hypnotic qualities. The dose is variously given as fifteen, forty, forty-five, and even sixty grains.

Phenocoll, which is closely related to phenacetin, has been recommended both as an antipyretic and analgesic. In the latter capacity it has shown itself of special value in rheumatism, the pains of which often yield to it readily.

It occurs as a crystalline powder of whitish color,

is soluble in water, and may be given several times a day, in doses of from ten to fifteen grains.

Para-acetophenetidin, or "phenidin," is an analgesic of considerable value, being regarded by some as superior to antipyrin. It is closely related in its chemical structure to phenacetin, and may be given in doses of from ten to fifteen grains several times a day.

Napelline is an alkaloid derived from *Aconitum napellus*, and is said to be an analgesic of considerable value. I have not as yet had occasion to employ it. The remedy, which is soluble in water, has been given in doses of from one-fifth to one-half of a grain.

Methylene blue, as its name sufficiently denotes, is a crystalline powder of bluish tinge, and has been considerably employed as an analgesic. It is soluble in diluted alcohol, but is best given in cachets or capsules, in doses of from two to six grains.

Iodopyrin, as its name implies, is a chemical combination of antipyrin and iodine. It has been principally employed as an antipyretic and analgesic, but in the latter capacity it hardly equals antipyrin.

On account of its insolubility the remedy is given in cachets, in doses of from two to ten grains.

Methacetine, or *paraoxymethyl-acetanilid*, is a remedy which of late has been commended as an analgesic and antiseptic. It is soluble in alcohol and chloroform, and may be given in cachets, in doses of from two to four grains.

Local Analgesics.—Among the substances the local application of which (hypodermically) to painful areas is capable of relieving pain by the induction of insensibility in the part are cocaine and its various salts, methoxy-caffeine, kava-kava, and helleborein.

Of these cocaine easily stands at the head, though the last-named substance, which is quite soluble in water, would be more valuable could it be employed more freely without danger of producing constitutional symptoms.

Methoxy-caffeine may be given in doses of from three to four grains.

Subsequently I shall detail at some length the various means to be employed in order to realize the fullest benefit from the use of these substances in the treatment of local pain.

CHAPTER XIII.

SUMMARY OF OTHER IMPORTANT FACTS RELATIVE TO THE ACTION OF REMEDIES ON THE NERVOUS SYSTEM.

In the previous chapters have been enumerated some of the more conspicuous and important substances used in the treatment of pain. It would be an error to suppose, however, that what has already been said is sufficient to enable us to proceed without further ceremony to the effective employment of these remedies. To appreciate this fact it must be borne in mind that substances introduced into the organism for remedial purposes are capable of being materially modified in their action by a variety of circumstances which concern both the individual acted upon and his environment.

Let us consider for a moment some of the more important phenomena bearing on this question, and especially those which relate to the action of remedies on the central and peripheral nervous systems; for it is with the latter that we shall be chiefly concerned in dealing with pain.

The first and, indeed, the cardinal fact connected with the action of remedies upon the central nervous

system is that they exert their influence upon that system through the circulation; for only so long as they remain dissolved in the blood are they conveyed to the structures contained in the cerebro-spinal canal. Moreover, it follows that, as the heart's action is dependent upon nervous innervation, it, too, can be modified only by remedies actively circulating in the blood-stream. The truth of this proposition, being capable of easy demonstration, is generally accepted, and needs, therefore, no further elucidation. But the fact, indisputable as it is, suggests this question: If remedies act through and by the circulation upon the cerebro-spinal nervous system, are changes in the blood-pressure followed by corresponding modifications in the physiological action of the remedy? The reply to this is that, at least in the case of some remedies, changes in the blood-pressure are indeed accompanied (followed) by commensurate variations in the physiological activity of the remedy. This applies with especial force to cerebro-spinal stimulants, and more particularly to those of an alcoholic and diffusible nature. It is applicable, moreover, to certain analgesics, notably antipyrin, and to some sedatives,—more especially the bromides. Hence it is that when the administration of these substances is preceded by the exhibition of a cardiac

tonic a notable increase in effect is observed to follow.

The same fact may, I believe, be invoked to explain another interesting phenomenon. What I refer to is this, that differences in altitude of sufficient magnitude to cause marked variations in atmospheric pressure are capable of modifying (increasing or decreasing) the physiological activity of drugs. That this is true has been attested again and again by travellers in the lofty regions of South America, where the atmospheric pressure is so reduced as to cause the constitutional disturbances known collectively as "mountain fever."

Inversely, it is a fact—which I was the first to show, as well as to make practical application of—that medicinal fluids, and more especially stimulants, are enhanced in their effects when exhibited while the subject remains in an atmosphere condensed to a notable degree beyond the pressure of the normal atmosphere.

To this conclusion I was inevitably compelled by a study of the habits of those persons who are obliged to labor in caissons and other devices employed in laying the foundations of bridges and submarine tunnels. In a subsequent chapter, dealing with the practical application which I have made of this principle in neuro-therapeutics, the

various matters at issue will be more thoroughly discussed; for the present, however, let me say that in my opinion these effects of compressed air are due to the increased vaso-motor tension consequent upon the augmented action of the heart on the one hand, and the pressure of the blood from the surface towards the cerebro-spinal canal on the other. This increased activity of the heart and augmented vaso-motor pressure in the central nervous system are the direct sequences of the air compression at the surface of the body; and their combined result must be a material increase of exosmosis of medicated blood within the organs of the cerebro-spinal canal. Herein we find, I believe, the explanation of the increased physiological effect.

The ability of heart tonics to augment the effects of certain stimulating, analgesic, and sedative substances is doubtless explicable in the same way. Another principle of considerable theoretic and practical interest connected with the administration of remedies designed to affect the cerebro-spinal axis is that the longer a remedial substance, dissolved in the blood, can be made to linger in contact with surrounding nervous structures the greater will be its physiological effect upon those structures. This is the fundamental principle underlying the localization of remedies upon the central and

peripheral nervous system as elaborated and expounded by the author. In a subsequent chapter the various technical details involved in its practical application will be more fully considered.

Yet another fact of importance connected with the administration of cerebro-spinal remedies is, that not a few of them are materially modified, both in the intensity and duration of their action, by the degree of activity prevalent in the excretory organs, and more especially in the kidneys. When elimination proceeds rapidly the duration of the action of the remedy will be proportionably shortened; whereas when there is present either renal disease or some other obstacle to excretion the drug accumulates in the system, and its physiological effects are necessarily prolonged. Moreover, it follows that if the doses be too large or their exhibition too frequent the accumulation may assume dangerous proportions. It is then that we are suddenly confronted with the phenomenon of "cumulative" action, the significance of which, though often enough alluded to in the books, is but too frequently lost sight of. And yet to ignore the possibilities of danger implied by the process is to court fatality. This applies especially to the administration of many of the coal-tar derivatives previously described, substances which, though emi-

nently useful in the management of pain, are at the same time burdened with the disadvantage that they exercise a decided depressant effect upon the heart when allowed to accumulate to an inordinate degree in the system.

When called upon to give these remedies I am in the habit of safeguarding their administration in a twofold manner: first, by due examination of the kidneys, which enables one to determine whether there be grave disease, contraindicating the administration of the remedy, or only a lethargy of action which may be adequately overcome by a diuretic; and, secondly, by the previous exhibition of a heart tonic, even though there be no evidence of feeble action or organic disease. By the observance of these simple rules I have been able, I am sure, to ward off trouble on more than one occasion.

There is hardly an analgesic or, indeed, for that matter, a remedy of real potency which is not capable of exercising some collateral ill effect on the organism. Our aim should be to ferret out these associated disadvantages and to neutralize them as best we may by the simultaneous exhibition of correctives. This is self-evident.

And yet there are those who are never weary of decrying the use of drugs on account of this concomitant harmfulness, forgetting that if the logic

underlying such outlawry were really carried to its obvious sequences we should soon find ourselves bereft of practically all the really good things of internal therapy.

Another point connected with the administration of cerebro-spinal remedies which is not always sufficiently appreciated is that old age is remarkably tolerant of stimulants, which seem, indeed, to afford substantial aid to the vital processes. This tolerance of stimulants is directly due to the relative obtuseness of the nervous system, which is so characteristic of the aged. Inversely, it is this very insensibility of the central nervous system in old persons which renders them intolerant of depressants, for these serve but to clog still further the already decrepit and irresponsive mechanism.

A condition closely resembling this senile lethargy of the nervous system may be induced artificially, notably by the prolonged and immoderate use of alcohol. In persons who have suffered from such addiction narcotics, and especially stimulants, fail to act with their accustomed energy, and hence considerably increased doses are demanded in order to obtain even moderate effects.

Herein lies the explanation, or, at least, the partial explanation, of the fact that the majority of patients encountered in public hospitals require much larger

doses than the refined persons met with in private practice. Destiny has decreed for the former class severe physical toil, with alternating excesses of a brutal character. The ultimate result of this low living is a distinct loss in nervous resiliency, and the consequent establishment of a condition of obtuseness as regards extraneous stimuli of all kinds. Quite the opposite condition is discernible in persons of refinement, for with them a sedentary and comfortable mode of life—the exigencies of which are a constant appeal to the mental rather than the physical side of life—has culminated in the development of increased nervous irritability, of which marked susceptibility to drugs is but one of the modes of expression. Every practitioner of experience will, I am sure, be able to recall many cases illustrative of this point.

Finally, the various peculiarities of temperament and idiosyncrasy should all receive due consideration in determining the character of the remedies to be employed as well as their proper dosage.

In the following pages an attempt will be made to apply in practice some of the principles enunciated in this chapter, and, notably, those pertaining to the localization of analgesics and the administration of stimulants and sedatives under increased atmospheric pressure.

CHAPTER XIV.

ON THE AUTHOR'S METHODS OF EMPLOYING REMEDIES SO AS TO INCREASE THE CERTAINTY AND DURATION OF THEIR ACTION ON THE PERIPHERAL NERVES—OTHER MEASURES WHICH HAVE BEEN PROPOSED.

From what has been said regarding the conduction of sensory impressions, it is evident that pain may be abolished in one of two ways: 1, by preventing the propagation of the morbidly intense impressions through the centripetal conducting paths (nerve and cord) to the sensorium; and, 2, by so obtunding the perceptive mechanism that morbidly intense impressions, even when transmitted to the brain, are not felt to be painful. The first of these methods embraces all of those means which are applied to the nerve or cord with a view to preventing irritation, or at least interfering with its propagation to the brain. In this category belong the various chemicals, the surgical expedients, the counter-irritants, the thermic agents, and, in short, all therapeutic measures addressed to the nerve itself. To these must also be added all such means

as we are able to bring to bear upon the sensory conducting paths of the cord, for, as Erb long since observed, pain is seldom quite absent in diseases of the cord, though it may vary extremely in form and distribution. These pains are usually attributable to irritation of the posterior root-fibres, and their distribution will, of course, depend upon the extent to which the structures in question are implicated.

The degree of permanency, and, consequently, the prognosis of such pains, will, however, depend upon the nature of the central lesion; if the latter be due to the inflammatory condition present in the disease known as locomotor ataxia, or to pachymeningitis, the chances of permanent recovery are reduced to a minimum; whereas if passive congestion, as we find it, for example, in the caisson disease, be the cause of the central irritation, the prospect of getting rid of the pains is proportionately enhanced.

Finally, under the head of the second method are included all appeals made to the receptive (perceptive) mechanism of the sensorium, in the form of opiates or other agents which tend to diminish acuity of sensory perception.

1. The Application of Remedies to the Centripetal Conducting Paths—Medication of the Nerves.—A large number of remedies may be applied to

affected nerve-filaments, either by the aid of the hypodermic syringe, endermically, or electro-chemically. Of the last-mentioned method I shall speak at once, not only because I was the first in this country to draw attention to its merits in connection with the use of local analgesics in the treatment of pain, but because I have devised a procedure for carrying out the details of this form of medication which I believe to be far more practical and effective than anything of the kind heretofore proposed. Before describing this method, however, let me observe that it is not my intention on the present occasion to enter into an extended discussion of the intricate pharmaco-dynamical questions involved in the treatment of pain. To do this would presuppose an intimate knowledge of the chemical constitution of nerve-tissue,—and such knowledge is at present denied us. While we cannot, therefore, know what chemical reactions are produced by the contact of a given medicament with the substance of a nerve, we may at least take cognizance of any considerable modification in the function of the latter thereby induced.

Adopting this mode of reasoning, we find that with the remedies and methods available we are able to accomplish three things: we may temporarily suspend the conduction in a nerve; or we

may change its constitution sufficiently to allay irritation, and thus prevent the genesis of the exaggerated stimulus which gives rise to painful perceptions; or, finally, we may destroy the morbid nerve-filaments altogether. The first result is best accomplished by the use of a local anæsthetic; the second, by the subsequent application of chloroform, ether, or similar agents, or by mechanical or thermodynamic aids; while the last is attained by the use of the knife. The first of these procedures is the one to which I give preference in cases of moderately acute pain, of unmistakably local character; the second finds its true field of application in those cases where it is desirable to produce a profound alterative effect upon the nerve; while the last, or surgical method, should be resorted to only in extreme cases, and after all other forms of treatment have failed to give relief.

My first object, therefore, will be to show how remedies may best be introduced into the vicinity of affected nerves, and particularly those of the skin; and how, when desirable, the action of medicinal substances upon the painful regions may be perpetuated.

Introduction of Remedies into the Skin by the Aid of the Galvanic Current.—The procedure which I have found effective for the purpose is an

improvement on that first described by me in 1886.[1] Its essential features are as follows: the region to be saturated with the chemical is first perforated by a large number of delicate needles,[2] which are driven into the part by releasing a spring, much after the plan of the old-fashioned spring lancet. The object of this manipulation is to increase the porosity of the skin, thus enabling the current to propel the chemical into the deeper tissues. As observed in the foot-note, however, it is of the utmost importance to employ only needles of the finest make, as, when larger ones are used, coarse openings are made, which no longer belong in the category of "pores," and through which the chemical refuses to pass. On the other hand, the minute openings made with extremely fine needles are not visible to the naked eye, but are seen by the aid of a strong magnifying-glass as a collection of dots.

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[1] New York Medical Journal, vol. xliv., November 19, 1886. See also Dr. David Webster, on "Corning's Method," Medical Record, March 5, 1887. Benjamin Richardson, of London, was one of the first to employ the galvanic current in conjunction with a chemical (chloroform) with a view to inducing local anæsthesia. This was long before cocaine was even heard of.

[2] This is nothing more than the instrument of the once famous charlatan Baunscheidt, supplied with unusually fine needles. The coarse instruments sold in the shops are of no value whatever, the needles being much too large.

Having thus increased the porosity of the skin, it only remains to introduce the chemical into the tissues by the aid of the galvanic current. In order to accomplish this we proceed as follows:

Two or three thicknesses of linen cloth are saturated with a five or six per cent. solution of the analgesic (cocaine), to which may be added, if considered desirable, a few drops of the tincture of aconite. The linen cloth thus treated is then laid carefully over the perforated area of the skin, care being taken to avoid folds or other inequalities of its surface. A layer of potter's clay, of a consistency to be readily fashioned to any inequality of the body, is then spread over the linen cloth to the depth of about an inch. In this layer of clay we then imbed a thin sheet of copper or wire gauze. This clay electrode is then maintained in place by the aid of an elastic strap.

The sheet of gauze or copper is then secured to the positive pole of an ordinary galvanic battery by means of the conducting cord, so that the current passes directly through the clay electrode and exercises its influence upon the analgesic contained in the cloth.

As to the negative pole, I will merely state that it is to be placed as near as possible to the positive pole, *but without touching it.* A broad, flat sponge,

saturated with warm water, and held in place by an elastic strap, is quite sufficient. With regard to the strength of the current to be employed, much will depend upon the situation and extent of the territory to be medicated. The greater the area to be anæsthetized the stronger and more protracted must be the application, always bearing in mind, however, that treatment of the head and face must be conducted with caution, care being taken to avoid currents of too great strength. As for myself, I usually begin with three cells, gradually increasing their number until five or six are brought into requisition. When the application is made to other parts of the body, as, for example, to the extremities, currents of very much greater strength may be employed. Currents of considerable quantity, such as those obtainable from large zinc and carbon cells, are preferable to all others. It is quite impossible to lay down infallible rules as to the length of time the current should be allowed to operate, since much must depend upon the strength of the battery and the extent of the territory which it is desired to medicate. From ten to twenty minutes are often quite sufficient, while under exceptional circumstances it may even be advisable to let the current do its work for a longer time. In the majority of cases the pain will have left the part after the cur-

rent has operated for eight or ten minutes. As a matter of course, should it be deemed advisable, supplementary injections of pyrogallic acid, theine, antipyrin, or other remedies may be made with a view to producing more pronounced and permanent effects upon the nerve.

Again, it is often desirable to expose the affected nerve-filaments to the action of chemicals for a considerable length of time. This is not, however, to be attained by merely depositing the remedy in the vicinity of the nerve or its ramifications without further precautions. In order to prolong the action of a remedy when thus injected we are obliged—as I long since pointed out—to resort to certain supplementary expedients. These I shall now proceed to describe.

The Prolongation of the Local Action of the Remedy—Author's Methods.—When a remedy is injected into one of the extremities it is an easy matter to perpetuate its action to any reasonable extent. We have only, in fact, to suspend the action of the arterial and venous circulation, as I long since demonstrated,[1] by the aid of an appropriate

[1] "On the Prolongation of the Anæsthetic Effects of the Hydrochlorate of Cocaine when Subcutaneously Injected: an Experimental Study," New York Medical Journal, September 19, 1885; "Prolonged Local Anæsthetization by Incarceration," ibid., Janu-

bandage. By this simple means we are enabled to keep the remedy for a certain length of time in contact with the nerve-filaments; for, the circulation in the part being suspended, the blood cannot dissipate it (the remedy) throughout the organism. Likewise, about the breast and back, we can accomplish the same thing, though in a much less perfect manner, by resorting to compression by the aid of rings, clamps, and the like. When, however, we desire to perpetuate more completely the action of the drug in the dorsal or thoracic region, the problem is wholly different, since rings and similar devices are not adequate. To meet this difficulty I have devised the following procedure:[1]

Having introduced the remedy throughout the

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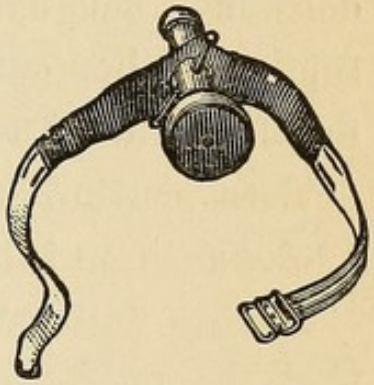
ary 2, 1886; "Spinal Anæsthesia and Local Medication of the Cord," ibid., October 31, 1885; "Local Anæsthesia," New York, D. Appleton & Co., 1886. See also Wyeth, John A., on "Corning's Method of inducing Cocaine Anæsthesia," "A Text-Book on Surgery," New York, 1887, p. 22; also Smith, Stephen, on Corning's method, "Principles and Practice of Surgery," Philadelphia, 1887, p. 54 *et seq.* See other communications on the subject by J. R. Conway, J. Williston Wright, Robert F. Weir, M. J. Roberts, and others.

[1] "The Medication of Nerves, and its Application in the Treatment of Neuralgia and other Painful Affections," a paper read before the Medical Society of the State of New York, February 1, 1887, published in the Medical Record for March 19, 1887.

painful territory, according to the method previously described, I place over the part a piece of fine wire gauze, which is trimmed with a pair of scissors so as exactly to cover the medicated zone. A T-shaped block of wood (Fig. 5) is then placed upon the wire gauze, and a considerable degree of pressure applied, by means of an elastic strap which encircles the body and is secured in place by means of a buckle. The same thing may be accomplished by placing a heavy lead weight upon the wire gauze while the patient remains in a recumbent position. As a result of this the gauze is pressed well into the skin, and the septa of the same cause occlusion of the subjacent capillaries, but without pressing out the remedy, which remains caught, as it were, in the meshes. By this method I have often produced a state of complete anæsthesia (by the use of cocaine alone or with antipyrin) lasting an hour and a half. It is not surprising, therefore, that such a protracted exposure of the nerve-filaments to the influence of chemicals should often result in permanent abolition of the painful sensations. Where the pain is located above the eyes, as in supraorbital neuralgia, or in the temple, this mode of treatment

FIG. 5.



often acts like magic; but let me add that cocaine alone is by no means always adequate to secure this end; its function is rather to render the painless employment of other remedies possible.

Sometimes, in uncomplicated cases, one application is sufficient to abolish the pain for weeks or even months. In others, again, the pain may return after a few days, but with less intensity. In any event, constitutional treatment should always be continued side by side with local measures, so that septic or other conditions which incite or favor the development of neuritis may be removed.

Therapeutic Thrombosis, or the Localization and Prolongation of the Action of Analgesics and other Remedies without Mechanical Aids.—It is obvious that the mechanical aids previously described are not equally applicable in all parts of the body; and hence it would be a great advantage if one could attain the same end—localization of the remedy—in some other way. Appreciating this fact, I addressed my efforts, some time since, to the problem of dispensing with them altogether; and in the New York *Medical Journal* of December 26, 1891, vol. liv., I have given an account of these researches.

Let me describe this method of perpetuating the action of remedies, and more especially local anal-

gesics and anæsthetics; and, to facilitate the recital, let it be assumed that we wish to perpetuate the action of an anæsthetic upon the cutaneous nerves.

In the first place, four principles are embodied in the procedure; these are:

1. Injection of the medicinal solution (anæsthetic) into the skin.

2. Subsequent introduction through the same hypodermic needle, and without its removal from the part, of a non-irritant oil.

3. Precipitation of this oil, after its injection into the skin, by the aid of moderate cold, *but without freezing the tissues.*

4. Taking up the slack of the skin near the seat of injection.

The technique involved in the practical application of these principles may be thus described:

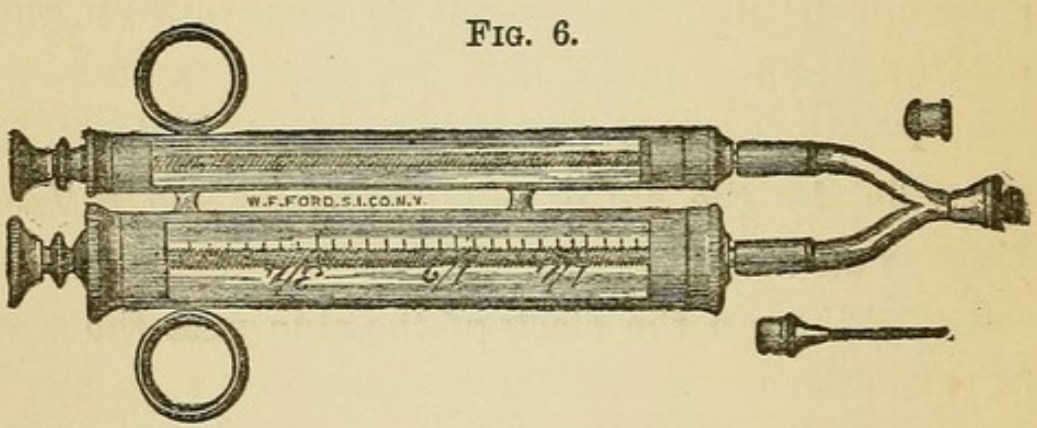
In the first place, we inject an aqueous solution of the anæsthetic, cocaine ($C_{17}H_{21}NO_4$,HCl), into that portion of the skin which we desire to render insensible. Then, without removing the hypodermic needle, we immediately inject a considerable quantity of the oil of theobroma, or cacao butter, as it is commonly called.

Finally, by the application of cold to the skin directly after the execution of these manœuvres, we cause the oil to solidify within the parenchyma,

thus obstructing the circulation in the capillaries and causing more or less complete stasis.

To carry these manipulations into effect a double syringe is required, one barrel containing a two or three per cent. solution of the hydrochlorate of cocaine and the other the oil of theobroma, which is maintained in a fluid state by occasionally dipping the syringe into warm water of about 110° F.

Fig. 6.



The capacity of the barrel containing the anæsthetic is one hundred minims, while that destined for the oil will readily hold four or five hundred minims.

Both of these barrels are connected by means of a bifurcated tube with the same needle; so that, by pressing first upon one piston-rod and then upon the other, the two liquids may be injected alternately through the needle at the will of the operator (Fig. 6).

I wish to acknowledge the carefulness with which

Mr. W. F. Ford, the instrument-maker, has followed my instructions in making the syringe.

It is absolutely necessary that both the aqueous solution of the anæsthetic and the oil should proceed along the same path, so that the occlusion of the capillaries shall occur immediately after anæsthetization of the sensory filaments in their immediate vicinity. Hence the necessity of employing a double syringe and an aqueous solution of the anæsthetic,—a solution that does not combine or solidify with the oil of theobroma, but remains fluid, and therefore physiologically potent, about the filaments of the sensory nerves. It is evident that oleaginous solutions of the alkaloid (cocaine) are inapplicable, for the simple reason that they combine and then solidify with the oil of theobroma, and are thus rendered inoperative, as is shown by the immediate disappearance of the anæsthesia.

The precipitation (solidification) of the oil in the tissues may be accomplished by the application to the skin of either cold water, ice, or the ether spray. I prefer the latter expedient. It is by no means necessary to spray the parts continuously, occasional refrigeration being all that is required to maintain the oil in a solid state within the tissues. To appreciate this point, it must be borne in mind that the melting-point of the oil of theobroma is from

86° to 95° F., so that a reduction in temperature of from 15° to 20° is sufficient to keep the oil in a solid state within the parenchyma. Moreover, the oil of theobroma is specially applicable on account of its bland, non-irritating properties, which admit of its injection in large quantities without the least chance of unpleasant consequences.

As a matter of course, having served its purpose, the oil is melted and deported by the general circulation when the application of cold to the skin is discontinued.

But even during the application of cold there is a gradual melting of the solidified oil, beginning at the periphery and proceeding towards the centre. In consequence of this the anæsthesia tends also to disappear at the periphery.

This subsidence of the anæsthesia may be enormously retarded by simply taking up the slack of the skin outside the zone of anæsthesia. To accomplish this it is only necessary to make a fold in the skin and maintain the latter by means of a strip or two of ordinary elastic adhesive plaster or by the application of a small spring clothes-pin, which may be had in the shops for a few cents. It must not, however, be inferred that stretching the skin is requisite to the attainment of the most complete results; all that is required is the elimination of the

excessive elasticity of the skin at the seat of injection. When this is done in the simple manner previously described the tissues above the solidified fatty mass —and nowhere else—retain a milky-white appearance as long as the oil is maintained in a compact condition by the judicious application of cold. As soon, however, as the fatty mass is allowed to melt, or, in other words, when we neglect to spray the injected area with ether from time to time, the skin resumes its normal appearance and the anæsthesia is at an end. Here we have the absolute demonstration of the efficacy of the hardened oil to practically arrest the capillary circulation at the seat of injection.

By the application of these principles I have succeeded in maintaining a limited zone of anæsthesia for considerably over an hour, and I see no reason why the anæsthesia should not be maintained for two hours or more.

I fancy that, to the practical members of the profession, this procedure will speak for itself, and I shall therefore refrain from commenting further upon it.

The expedients heretofore discussed are such as have reference to the treatment of pain when due to implication of the superficially-located nerves, and, notably, those of the skin. But pain is by no

means always due to implication of these nerve-branches; on the contrary, it is often traceable to changes in or about the trunk itself, which may be profoundly located, as in the case of the sciatic nerve. How to deal effectively with pain when originating in this way is one of the interesting problems of medicine.

As for myself, I have striven to meet the indications in a variety of ways. Sometimes I have injected chemicals, such as pyrogallic acid, cocaine, and aconite, down to the nerve by the aid of a long, fine needle and syringe. Then, in order to insure a more complete exposure of the affected nerve-tissue to the influence of the chemicals, I have passed a tourniquet around the limb, above the point of injection, securing it with sufficient tightness to shut off the circulation in *both artery and vein.* The obvious effect of this is to prevent the deportation of the injected chemicals into the general circulation; consequently, they linger about the nerve, and are able to do their work as long as the tourniquet remains in place.

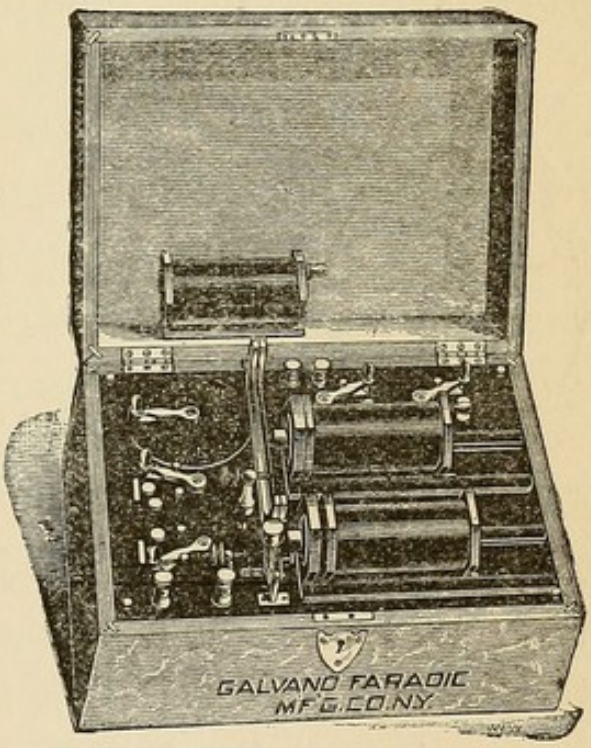
To render the pressure of the tourniquet bearable, however, it is imperatively necessary, before applying it, to exsanguinate the limb with an Esmarch bandage.

Several years ago I published some cases illus-

trating the favorable results which are sometimes attainable by this plan of treatment.

In addition to the measures previously described a large number of other expedients have been resorted to in the treatment of pain. Prominent among these is *electricity*, which in the form of the galvanic, and more especially the induced (Faradic), current has been extensively employed. Within a short time, too, a great improvement has been made in the construction of the Faradic battery, and, notably, in the vibrator or rheotome, by means of which an enormous number of interruptions is secured, thereby enhancing to a material extent the analgesic properties of the current. By far the best battery of this kind is that suggested by Dr. Augustin N. Goelet (Fig. 7); it is constructed in a most elegant manner by the Galvano-Faradic Manufacturing Company, of New York.

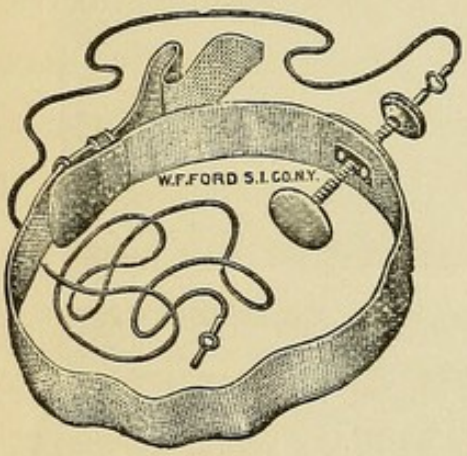
Fig. 7.



It has long been known that *pressure* applied to the stem or larger branches of a nerve is often instrumental in arresting pain. But the procedure is much more effective when combined with the use of the Faradic current, as was pointed out by the author several years ago.

To carry out this combined treatment I have had made for me an electrode provided with a stout leather band to encircle the limb. This band is pierced by a screw, by the rotation of which the pressure may be increased or decreased at will. A binding post at the top of this screw serves to attach the conducting cord, which unites the electrode with one of the poles of a Faradic battery (Fig. 8). The pad of this electrode is covered with chamois-skin, which should be thoroughly moistened before applying it to the part. As a rule, the electro-pressure should be applied centrally,—*i.e.*, as high up as possible; whereas the electrode designed to complete the circuit should be located at the periphery. Thus, in treating sciatica, the foot of the patient may be allowed to rest on a metal electrode, while the

Fig 8.



pressure-electrode is placed over the nerve, as near its point of exit from the pelvis as possible.

The application of *cold* to the painful area is an old expedient. The usual mode of accomplishing it is by projecting an ether spray upon the part, as suggested by Sir Benjamin Richardson. Packing the whole limb with ice has also been resorted to, notably in the treatment of sciatica.

Heat has been even more extensively employed than cold in the treatment of pain, either in the form of cloths saturated with hot water and renewed at frequent intervals; or by means of hot plates of metal enveloped in flannel; or by the aid of rubber bags filled with hot water, as suggested by Dr. Chapman. When applied to the spine in this way some effect upon the central nervous system is doubtless produced; but the miraculous phenomena described by Chapman and some of his followers are, in my experience, not forthcoming. But, while this indirect method is of relatively restricted utility, it is a matter of common professional experience that the direct application of heat to the seat of pain is often, though certainly not invariably, productive of relief.

Counter-irritation, either in the form of blisters or acupuncture, has been extensively resorted to from a remote period. In the last-named form it has

been employed in China for centuries, special virtues being ascribed to the long needles of gold and silver, which are thrust, it is said, without hesitancy into almost all the accessible regions of the body. Such empirical procedures have, however, hardly more than an historical value, being manifestly inferior to modern scientific methods.

Ointments of various kinds have long been employed in the treatment of pain.

The remedies best suited to be applied in the form of salves in neuralgic affections are veratrine, morphine, belladonna, aconitia, and extract of opium.

Aconitia (one part to thirty) should be rubbed into the painful areas until numbness is induced.

Veratrine (one part to twenty-five) may be applied twice or thrice daily, care being taken to continue the friction until pricking sensations are experienced. Erb recommends one part of belladonna, four parts of glycerin, and four parts of starch, the ointment to be applied on a compress or rubbed into the painful cutaneous districts.

CHAPTER XV.

SURGICAL EXPEDIENTS.

As is well known to every medical man of extensive experience, cases of pain are occasionally met with which we are not able to relieve, much less to cure permanently. In such desperate cases as these it is customary, as a last resort, to invoke the assistance of surgery.

The two procedures commonly employed are neurotomy and neurectomy. The first operation consists in simple division of the nerve above the point of irritation; while the second is a more radical procedure, involving resection of a portion of the affected nerve.

Both of these operations are, of course, undertaken with a view to preventing the propagation of the painful sensations to the brain.

Interference with the circulation in a painful region has been known to abolish permanently all unpleasant symptoms in the part.

This observation has led surgeons to ligate the arteries supplying the painful area. Thus, Trousseau

frequently divided and subsequently ligated the temporal and occipital arteries in neuralgia of the head; and the results thus obtained were sometimes quite remarkable.

Guided by a similar train of reflections, Nussbaum, of Germany, ligated the carotid artery in a desperate case of neuralgia of the face, with the happiest results, the cure effected being to all intents and purposes complete.

Inveterate cases of tic douloureux are, fortunately, not so very common; but when they occur, the misery which accompanies them is inexpressible. Until 1851, when Dr. J. M. Carnochan operated by completely resecting the second branch of the fifth nerve, we were in a state of more or less helplessness when confronted by one of these old cases of tic.

Dr. Carnochan's mode of operating is thus described by Dr. Robert Abbe,[1] who has improved it in some important particulars: "A V incision was first made below the eye, and from its apex a straight cut was extended downwards through the entire cheek and lip half-way between the nose and the corner of the mouth. The nerve ends were

[1] "The Surgical Treatment of Inveterate Tic Douloureux," by Robert Abbe, M.D., the New York Medical Journal for August 3, 1889.

then gathered up at the foramen of exit, and a trephine was applied to the front of the jaw, removing the front bony wall of the antrum. The roof of this cavity, being of thin bone, is readily broken in, and the nerve drawn down from the orbital cavity. The back of the antrum is next broken away and removed, which exposes the spheno-maxillary fossa, which at this point is little more than half an inch deep. The nerve can now be cleaned away from its cellular surroundings and traced to the foramen rotundum, which is on a line with the inner wall of the antrum. Here it is readily cut square off. The posterior dental nerves and Meckel's ganglion connect in front of this, and thus all communication of the jaw with the nerve-centres is cut off beyond the chance of repair."

Dr. James R. Wood employed Carnochan's method of operating in a number of cases, and modified it only to the extent of abbreviating the incision, so as not to carry it clear through the lip.

Dr. Abbe has adopted some changes of technique which clearly enhance the value of the operation; for he observes, "the simplifying of dressings and attainment of primary union in the wounds now possible make certain valuable modifications of the operation practical."

"I have adopted these expedients," he continues, "in three cases.

"The best point is the small skin incision, which leaves a small scar. One inch and a quarter, either horizontally, vertically, or obliquely, over the infra-orbital foramen gives ample room for operating. I have found a gouge better than a trephine for penetrating the antrum front and back. A narrow, forked, blunt instrument to straddle the nerve and assist in dragging it down into the antrum saves it from laceration.

"No bleeding occurs that is not readily checked by sponge-pressure, even the sharp welling-up that occurs when the nerve and its companion vessel are cut. The dressing of the wound is of special importance, and the most perfect result is obtained by packing iodoform gauze tightly into the antrum, the end of a long strip being folded into a small pad to be placed deep in the wound against the foramen rotundum, and the rest lightly added on top, and allowed to keep the wound apart on the cheek. After thirty-six or forty-eight hours this gauze is entirely removed and the wound sutured with care.

"The anæsthesia of the cheek allows of secondary suturing without pain to the patient. What little exudation may follow this dressing is retained and

needs no drainage, primary union invariably resulting if the dressing is made with care. The depressed scar becomes flattened after a few weeks."

The histories of the three cases operated upon by Dr. Abbe may be found in the paper from which the above extracts are taken.

I will finally observe in this connection that Dr. Frederic S. Dennis,[1] of New York, collected twenty-one cases of this operation several years since, an analysis of which affords ample proof of the merits of this surgical expedient. A perusal of Dr. Dennis's admirable paper will be found alike interesting and instructive.

It is much to be regretted that in a large number of painful conditions, owing to the fact that so many nerve-trunks contain both sensory and motor fibres, division of the nerve cannot be resorted to without the simultaneous induction of paralysis of motion.

Division of the Sensory Nerve-Roots for Inveterate Pain.—Attention has just been drawn to the fact that the majority of those nerves most liable to become the seat of neuritis contain both motor and sensory fibres. Hence division of such nerves with the knife, for the permanent relief of severe and chronic pain, is not usually justifiable, for the

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[1] The New York Medical Journal for June, 1879.

simple reason that the operation not only destroys the sensibility in the part but (what is much more deplorable) it also induces paralysis. In order to avoid causing such paralysis of the muscles it has been proposed to divide the posterior nerve-roots, from which the sensory filaments of the affected nerves are derived. To do this successfully involves a knowledge of what nerve-roots go to make up the various plexuses and nerves most liable to be attacked by severe neuritis. Thus, if we are confronted with an inveterate brachial neuralgia which has resisted all forms of medical treatment, the question of an operation may imperatively suggest itself to the mind of the patient or his friends. Under such circumstances, rather than reduce the arm to a state of helplessness by cutting or resecting the nerves, we may divide some or all of the posterior nerve-roots which contribute sensory filaments to the affected nerve or plexus, whereby sensation is lost but motility retained. All this has quite a plausible ring; but the practical realization is not always correspondingly satisfactory. There are two reasons for this. In the first place, as every physician is aware, it is not always easy to determine with absolute certainty just how many branches of a plexus (or nerve) are actually implicated in a given case of neuralgia, since some of the pains may be

"reflected;" and, secondly, if the simple nerve relations be often difficult to decide upon, how much more intricate must be the question as to the exact number of sensory nerve-roots which must be divided in order to obtain the maximum relief with the minimum of anæsthesia! No anatomical statistics, however well tabulated, afford an infallible key to the situation. Nor is any one to blame for this, since, as has just been shown, the complications are inherent and not readily amenable to simple *a priori* solution. Dispensing with theoretic refinements, we must make up our minds, then, to produce anæsthesia so extensive as to *absolutely* insure the abolition of the pain. This we may accomplish by dividing at once a sufficient number of posterior nerve-roots to rob the plexus of its sensory functions. The remedy is drastic, but vastly to be preferred to the ruthless expedient of division of the nerve itself with the attendant motor paralysis.

Removal of the Semilunar Ganglion for Obstinate Facial Neuralgia, as Practised by Rose and Andrews.—It would be a manifest omission were we to neglect to give a description of the radical and comparatively new operation of excision of the semilunar ganglion for intractable trigeminal neuralgia, as first practised by Dr. Rose, of London. An

exceedingly lucid and instructive account of this operation has been given by Dr. Edmund Andrews, of Chicago, who has already removed the ganglion several times.

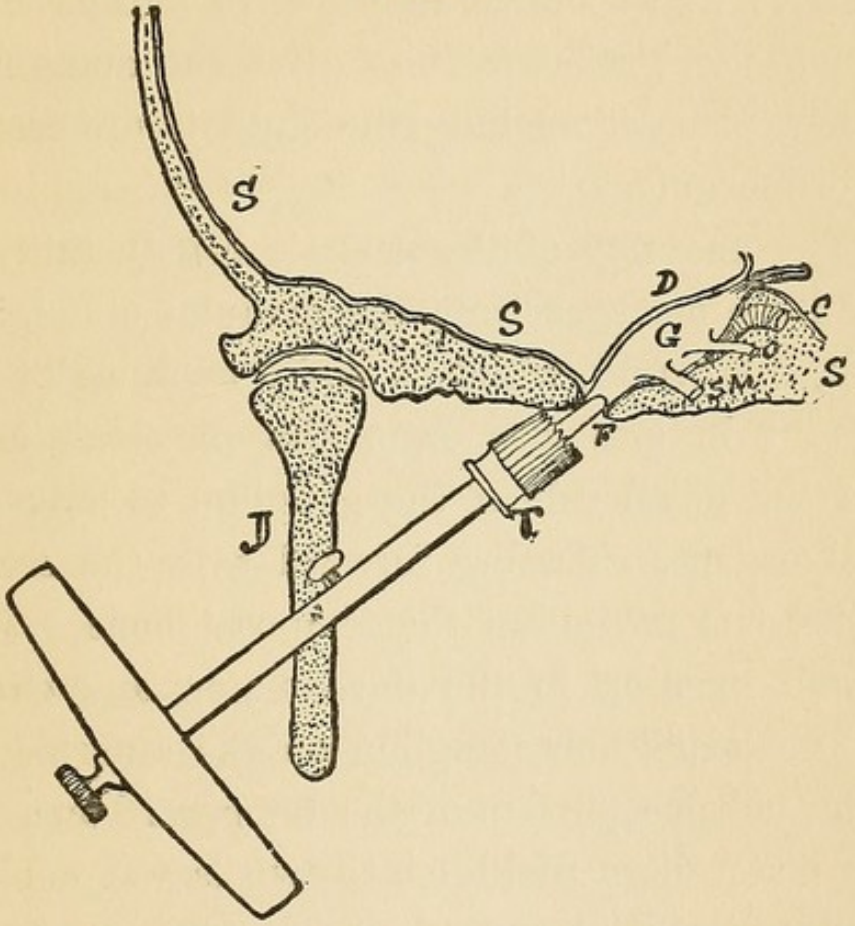
The following description with diagrams illustrating the technical points involved are taken from Dr. Andrews's admirable paper.[1] I desire also to express my acknowledgments to Messrs. Lippincott Company for kindly furnishing me the electrotypes from which these illustrations are made.

"The first operation of Rose was modified by the demands of the patient, who insisted that he should remove the superior maxilla, where he felt the principal pain. Professor Rose, in this instance, therefore, consented to remove that bone. This uncovered the fossa behind it, thus gaining an easy access to the foramen ovale, from which the inferior maxillary nerve emerges. Placing the centre-pin of a trephine in the foramen, he took out a half-inch disk surrounding the orifice; then, opening the capsule of the ganglion, he divided the superior maxillary branch, and, with some difficulty, picked out and removed almost all of the ganglion. This

[1] "Two Cases of the Removal of the Semilunar Ganglion through the Floor of the Skull for Facial Neuralgia," by Edmund Andrews, M.D., etc., International Medical Magazine, vol. i., No. 5, June, 1892, p. 479 *et seq.*

was twenty-two months ago, and the patient still remains free from pain. In his second and third operations, Rose avoided the removal of the superior

FIG. 9.



Rose's first operation, with the long, blunt centre-pin of the trephine inserted into the foramen ovale. *S*, *S*, *S*, the floor and side of the cranium; *G*, the Gasserian ganglion; *F*, the foramen ovale; *T*, the trephine; *D*, the dura mater; *C*, the carotid artery; *J*, the lower jaw.

maxillary bone by uncovering the parts from the side of the face, as is shown in Fig. 12. In his fourth and fifth operations, he proceeded in essentially the same way, but on reaching the floor of

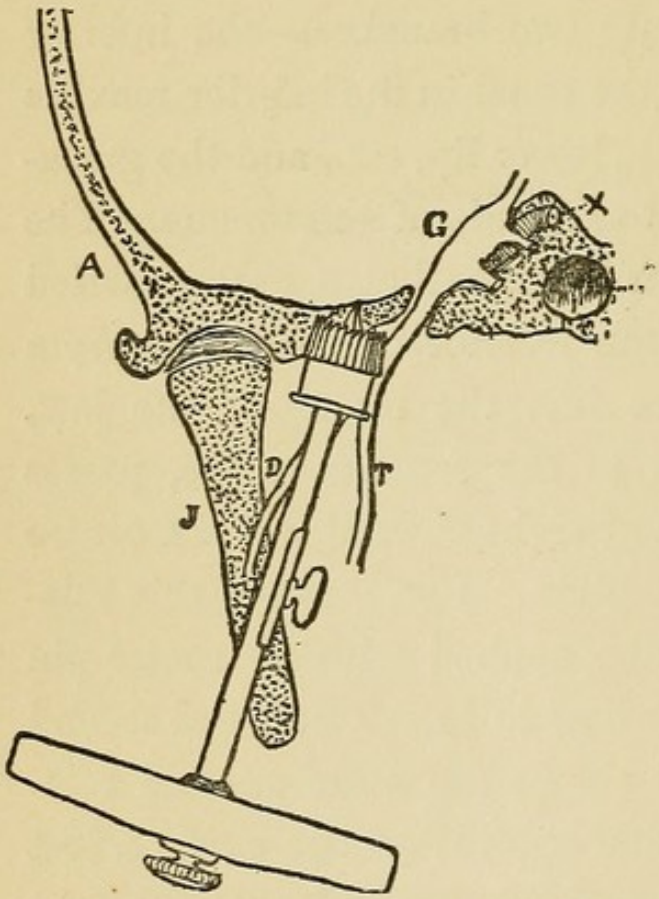
the cranium he selected the place for the application of the trephine, which I had previously urged before the American Medical Association,—that is, not directly upon the foramen ovale, but just external to it, as shown in Figs. 10 and 11. In a letter to me, Professor Rose gives the opinion that the new place of opening the skull is preferable to the former one.

"The anatomy of the parts is briefly this: The fifth nerve emerges from the medulla oblongata in a flat, soft trunk, which is easily torn, and is very different in structure from the divisions issuing from the distal side of the ganglion to supply the facial organs. Passing forward over the crest of the petrous portion of the temporal bone, it enters a small opening in the dura mater, and expands into the semilunar ganglion on the anterior slope of the petrous portion of the temporal bone. The dura mater here divides into two layers, enclosing the ganglion in a sort of capsule; the upper layer is thick and strong, and the ganglion is firmly adherent to it. The lower layer, next to the bone, is very thin and delicate, and the ganglion easily separates from it. The ophthalmic, with the superior and inferior maxillary trunks, is given off from the anterior edge of the ganglion to proceed to the face. The largest of these divisions is the inferior maxil-

lary, which emerges from the skull through the foramen ovale as a somewhat thick cord, very firmly invested with a prolongation of the dura mater, so that it is strong and will withstand a good deal of tension without breaking. Soon after leaving the foramen it divides into two branches,—the inferior dental, which enters the canal in the inferior maxilla and supplies the teeth, lower lip, etc., and the gustatory nerve, running to the side of the tongue. The direction of the parts is such that a probe carried along the trunk of the inferior dental nerve, from its point of entrance into the ramus of the jaw, upward and inward to the foramen ovale, passes through the foramen straight onward into the centre of the semilunar ganglion. Fig. 9 shows this relation, with the trephine applied with its centre-pin in the foramen, according to Rose's first and second operations. Fig. 10 shows the same general relations with the trephine applied to the surface, just external to the foramen ovale, and advocated by me as the best point before Professor Rose adopted it, though the latter's selection of it was the result of his own investigations without communication with me. Fig. 11 shows the relation of the parts at the base of the skull; *F O* is the foramen ovale, which gives exit to the inferior maxillary nerve; *F S* is the foramen spinosum, through which the middle

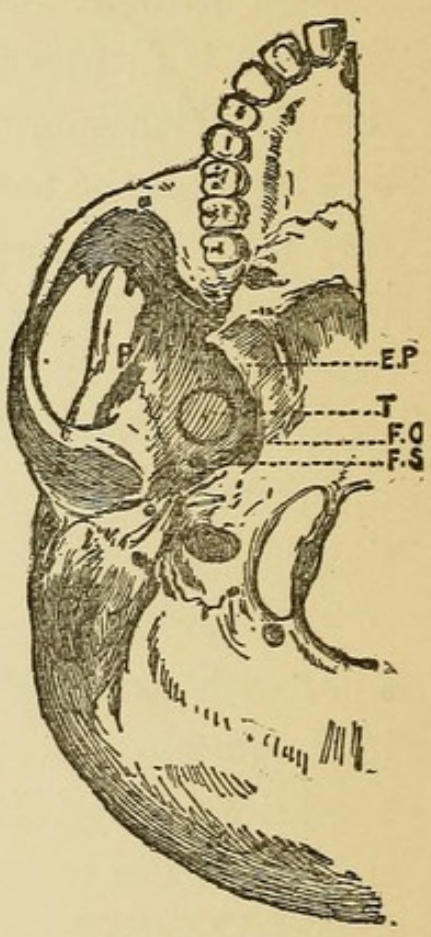
meningeal artery enters the skull; *E P* is the external pterygoid plate, whose free external edge runs directly to the anterior extremity of the

Fig. 10.



A, the cranium; *G*, the ganglion; *X*, the carotid artery; *S*, the sphenoidal sinus; *D*, the dental branch of the nerve; *T*, the gustatory branch, natural size.

Fig. 11.

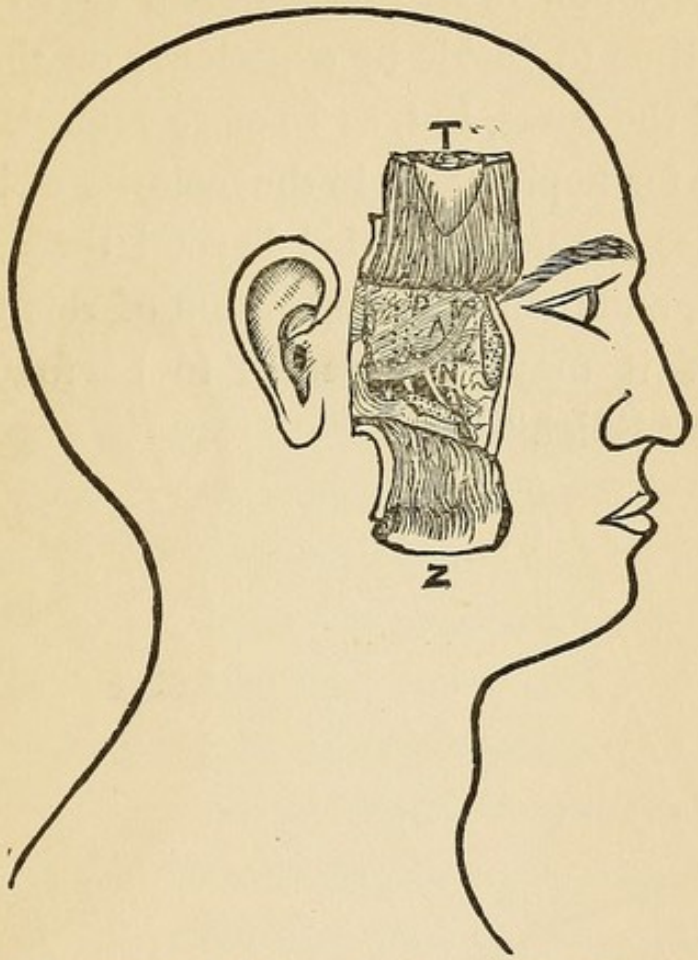


Shows the relation of the parts at the base of the skull. For description see text.

foramen ovale, but is sometimes prolonged by a ridge on the inner side, and sometimes on the outer side, but always close to it; hence it is an important landmark for finding the foramen; *P* is the ptery-

goid ridge, sometimes also an important landmark. The black circle on the drawing, just external to

FIG. 12.



Rose's second operation. *Z*, lower flap, containing zygomatic arch; *T*, upper flap, carrying up the coronoid process; *P*, external pterygoid muscle; *A*, superior maxillary artery; *N*, the gustatory and inferior dental nerves. Their course behind the pterygoid muscles is indicated by dotted lines. The foramen ovale is just back of *P*.

the foramen ovale, shows the place for applying the trephine."

In concluding his most instructive paper Dr. Andrews observes that "of the seven cases done

by Professor Rose and myself no one has shown any dangerous symptoms, and not one has failed to obtain perfect relief from the pain. The operation is so utterly new in its present form that there has been no time to decide by experience on the permanency of the cures, but, as I before remarked, there is reason for hoping that in the majority of instances the disease has not extended beyond the semilunar ganglion, and, hence, the operation of removing the whole of it may be expected to be followed by permanent relief."

CHAPTER XVI.

LOCAL MEDICATION OF THE SPINAL CORD.

I HAVE already referred to the frequency with which pain is associated with affections of the spinal cord, and I now desire to offer some suggestions regarding the most practical means to be adopted in the management of this troublesome symptom.

Let me preface the specific rules to be observed in treatment by a retrospective glance at the argument upon which those maxims are based.

To begin with my first paper on the subject of direct cord medication, I may state that as long ago as 1885[1] I showed that when a given amount of chemical substance, in aqueous or oleaginous solution, is injected into the vicinity of the spinal cord certain modifications in the functions of the latter may be induced.

Thus, when strychnine is injected in this manner, the functions of the cord, and, notably, the reflexes, are greatly exalted; much more so, in fact, than if the medicament had been simply injected into the

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[1] The New York Medical Journal for October 31, 1885.

general circulation, as in ordinary hypodermic medication. On the other hand, the modifications in function which I have observed after injection of an anæsthetic, such as cocaine, were sensory in character,—such, for example, as more or less complete anæsthesia, tingling, numbness, and various other paræsthesiæ, these phenomena being principally restricted to the lower limbs, scrotum, and other parts below the point of injection. The line of argument which led up to these results it is not necessary to detail on the present occasion; enough that the whole chain of experimental proof then and afterwards adduced[1] was amply verified in the clinic.

So convinced have I become of the necessity of making some radical improvement in our methods of dealing with pain originating in difficulties of the cord that, when I observed how vastly more potent are the effects of remedies when brought directly in contact with the cord than when introduced into the system in a merely general way, I determined to perfect the technique of making local applications to the organ, so as to place the procedure on a sound basis.

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[1] "Further Contribution on Local Medication of the Spinal Cord, with Cases," the Medical Record for March 17, 1888.

There was one obstacle in particular to be overcome in order to accomplish the practical ends of the undertaking.

Briefly stated, the problem in question is this: How is the physician to know how far he may thrust the hollow needle, used in transmitting the medicament from the syringe to the vicinity of the cord, without danger of wounding the latter?

As I have said, this problem puzzled me for a time; and yet there was no evading it, for I saw at once that if the procedure were to prove effective it could only do so by enabling one to deposit the medicinal solution close to the cord. This is how the matter was at length accomplished. Having examined the vertebræ of the lower portion of the spinal column, I observed that the posterior surface of the transverse process, even at its greatest depression, though almost on a level with the posterior aspect of the foramen vertebræ, did not fall at all, or, in rare cases, possibly very slightly below it. This is especially true of the ninth, tenth, eleventh, and twelfth dorsal and of the first and second lumbar vertebræ. As soon as I had observed this anatomical coincidence, I saw at once that, in so far as the lower vertebræ were concerned, the problem of approaching the immediate vicinity of the cord with the point of a hypodermic needle,

without danger of wounding it, was solved. In a word, to make the matter short, the simple technique which I elaborated on the basis of these observations is as follows:

1. I first, as a rule, induce a condition of cutaneous anæsthesia in the vicinity of the spinous processes of the tenth and eleventh dorsal vertebræ almost as large as a silver dollar. This I do simply for the comfort of the patient, and for no other

FIG. 13.

purpose. The electro-chemical method[1] previously described or refrigeration with the ether spray may be invoked for the purpose.

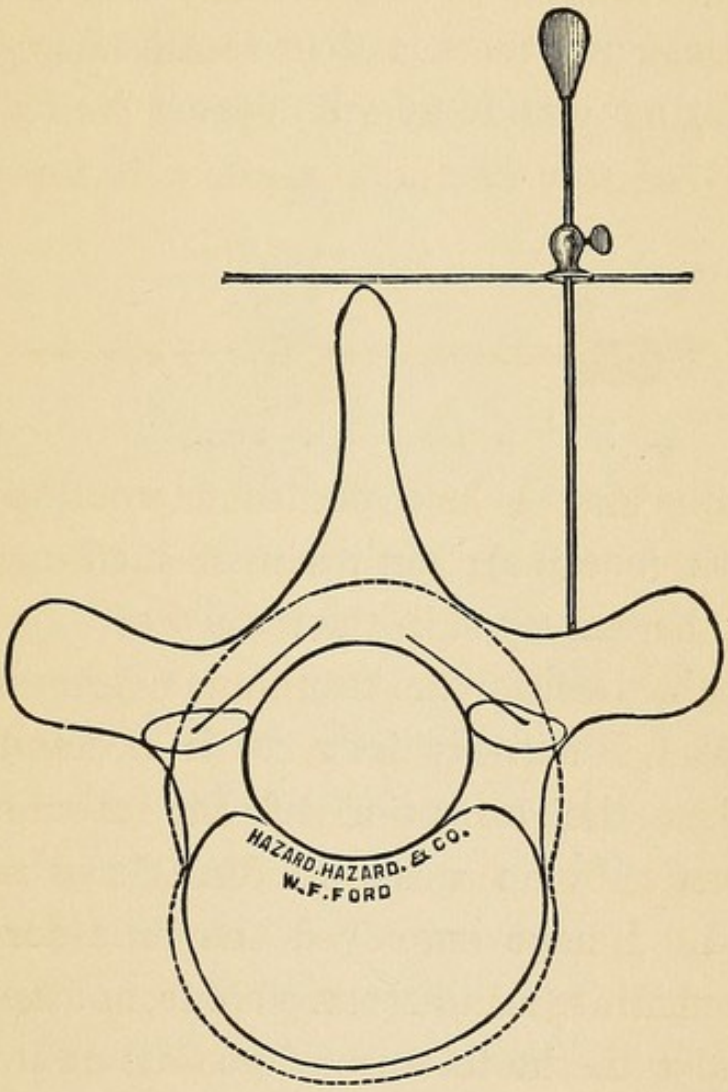
2. I now call into requisition a fine needle, about three inches long, provided with a handle and a sliding nut (Fig. 13). The latter may be fixed at any portion of the continuity of the needle by means of the screw. This needle I thrust down (about half an inch laterally from the spinous process of the tenth dorsal vertebra) until the bone is reached (Fig. 14). The nut is then pushed down till it rests lightly upon the skin, and is secured in

[1] See the New York Medical Journal for November 6, 1886.

place by means of the screw. I then withdraw the needle.

It is now clear, from what has already been said, that the space between the nut and the point of the

FIG. 14.



needle corresponds almost exactly with the distance from the surface of the integument to the cord. To make assurance doubly sure, however, I am in

the habit of subtracting two or three millimetres from the measurement thus attained.

3. Upon a fine canula (Fig. 15), likewise provided with a sliding nut, the distance previously noted upon the needle is measured off (minus two or three millimetres), and the nut secured firmly in place.

This hollow needle is then attached to a syringe (Fig. 16) of one hundred minims capacity, filled

FIG. 15.

with a one and a half per cent. solution of the anæsthetic (cocaine); antipyrin or methoxycaffeine may also be employed in the same way.

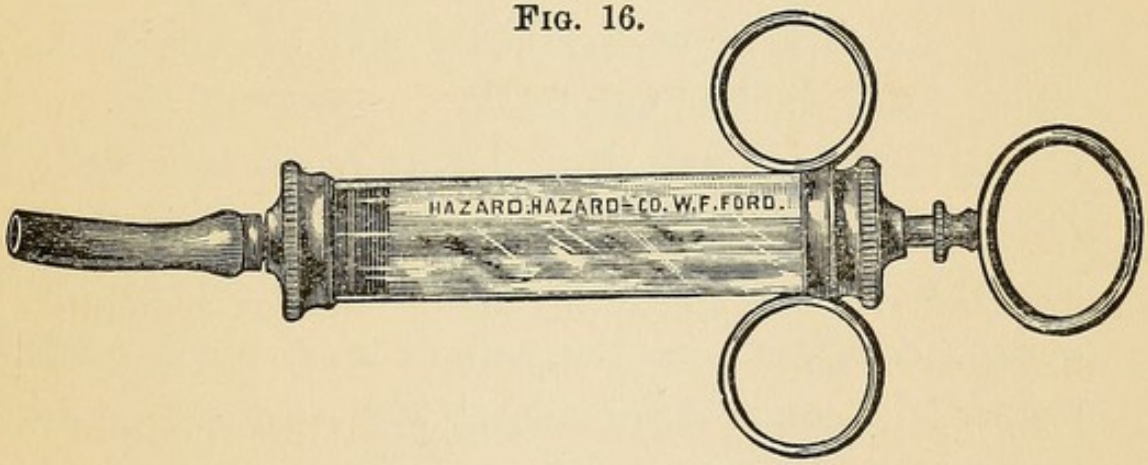
So much, then, for the technique of this mode of treatment. Relatively long as is necessarily the description, the execution of the manipulations themselves is by no means so difficult as might be imagined. I have employed the procedure many times, sometimes using cocaine alone, and sometimes combined with the tincture of aconite or pyrogallic acid, antipyrin, methoxycaffeine, or strychnine.

In the affection commonly known as spinal irritation—whether there be a condition of congestion or anæmia, I care not—its effects are certainly in the highest degree beneficial, as I have already had

occasion to demonstrate to my entire satisfaction in several cases. How much may be obtained in inflammatory affections of the cord only an extended experience can, of course, determine. In purely functional derangements, however, its efficacy is beyond question.

In the second paper alluded to in the foot-note—that published in the *Medical Record* of March 17,

FIG. 16.



1888—will be found a number of cases illustrative of the efficacy of this procedure. Several cases may also be found in the third edition of the author's monograph on "Headache and Neuralgia."

The Irrigation of the Cauda Equina with Medicinal Fluids.—While I was engaged in testing the method of medicating the spinal cord just described I became impressed with the desirability of introducing remedies directly into the spinal canal, with a view to producing still more powerful impressions

upon the cord, and more especially upon its lower segment.

As is well known to every physician, the cord, properly speaking, extends only to the first, or at most to the second, lumbar vertebra. The nervi lumbales, sacrales, and coccygei are therefore obliged to traverse a long distance within the spinal canal in order to attain their respective points of exit. It is thus that the parallel nerve-stems are formed at the lower end of the cord. These fasciculi, in their totality, constitute the so-called cauda equina. Now let us recall two well-known facts of anatomy: the first of these is that the pia mater, properly speaking, comes to an abrupt conclusion at the end of the spinal cord proper (the conus terminalis);[1] while the second is that the blind sac of the dura mater extends to the end of the canalis sacralis.

With the above data vividly before us we shall readily understand that when a needle is thrust down between the spinous processes of the third and fourth lumbar vertebræ, for example, close to the ligamentum interspinosum, the point of such a needle, after penetrating the dura mater, will

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[1] The filum terminale has no practical bearing on the argument; I therefore ignore it altogether.

find itself directly in contact with the filaments of the cauda equina, which from this point downward occupies the space of the spinal canal.

If such a needle be hollow and attached to a hypodermic syringe charged with a medicinal fluid, it is, moreover, evident that the solution may be readily deposited upon the filaments of the cauda. Again, there can be no doubt, especially if the injection be made between the second and third lumbar vertebræ, that the functions of the lower segments of the cord itself may be powerfully affected in this manner. We have only to conceive of the cerebro-spinal fluid being, at this point, thoroughly impregnated with the medicinal fluid and lying in direct contact with the pia,—we have only to conceive of this, I repeat, in order to be convinced of the potency of such a procedure.

As to the question of possible injury arising from pricking the filaments of the cauda with the needle, it must be borne in mind, in the first place, that serious disturbances of sensation and motility, having their origin in the cauda, are always due to gross lesions, and not to insignificant, circumscribed causes. The very fact that the cauda is composed of a great number of filaments, that these fill out the entire canal and are widely distributed, would *a priori* lead us inevitably to this

conclusion, did we not know inductively from clinical histories and subsequent post-mortem investigation that such is the case.[1]

Secondly, we must remember that the wounding of a nerve-stem (and the cauda is nothing more than an aggregation of nerve-stems) with a fine, sharp needle is practically without significance. There is an interesting observation bearing on this point in Weir Mitchell's well-known book on nerve-injuries, which we may here apply with perfect legitimacy. "The passage of a needle into the nerve of an animal causes," he says, "usually a little bleeding, which passes away without grave result."[2]

Such a statement applies to simple puncture with a fine needle; wounds made with an awl or other coarse instrument may, of course, set up the symptoms of circumscribed neuritis.

After a survey of the various factors involved as above indicated, and after some preliminary observations on animals, I decided several years ago to put to a practical test the possibilities of direct

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[1] *Vide* "Injuries of the Cauda Equina," by William Thorburn, M.D., Brain, vol. x. page 381 *et seq.*

[2] "Injuries of Nerves and their Consequences," by S. Weir Mitchell, M.D., Philadelphia, 1872, page 92, nineteenth line from the bottom of the page.

medication of the cauda equina as soon as a suitable case should present.

The first case in which I resorted to it was one of spinal irritation following an operation upon the urethra. I was called in consultation in the case ten days after the operation. At that time the spine was sensitive to pressure; there were several points of unusual tenderness located in the lower dorsal and lumbar regions; while the marks of frequent blisterings were still visible on both sides of the spinous processes. Various internal remedies, such as strychnine, ergot, and analgesics of different kinds, were prescribed, but without sensible improvement.

The patient readily consenting, I decided, therefore, to try the efficacy of an injection composed of Tinct. aconiti, gtt. v; cocainæ, gr. ss; aquæ, 3i. Sig.—For one injection.

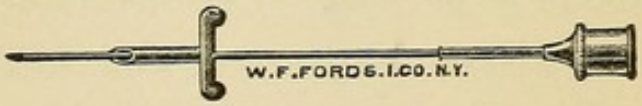
The foregoing amount of medicated solution I deposited directly upon the cauda equina in the following manner:

A small trocar, half an inch long, and of the diameter of a wax match, was first thrust through the skin between the second and third lumbar vertebræ. A long, fine, hollow needle, screwed to an ordinary hypodermic syringe, was then passed *through the opening in the trocar* and down through the

soft tissues adjoining the ligamentum interspinosum till the spinal canal was entered. The trocar and needle are shown in Fig. 17. The entire contents of the syringe were then emptied upon the fibres of the cauda equina.

In from five to eight minutes the subject described a tingling sensation in both lower limbs, slightly more marked, perhaps, in the left than in the right leg. On examination there proved to be a decided

FIG. 17.



impairment of tactile sensibility, amounting, in certain localities, particularly in the lower third of the thigh and ankle, to a positive anæsthesia.

Within a quarter of an hour, or at most twenty minutes, every remnant of pain had disappeared, and pressure upon the vertebræ failed to reveal any special degree of tenderness. These phenomena are certainly remarkable when we consider the facility and rapidity with which they were evoked.

I will merely add that there was entire exemption from pain during the next thirty-six hours; and when the pain and tenderness finally reappeared they exhibited a decided diminution in acuity.

The future course of the disease differed in no

essential particular from that of an ordinary case of acute spinal irritation. Recovery was soon complete; and, by avoiding severe bodily strain, particularly rapid walking, sitting for a long time, or bending the body forward and backward, the patient was able to avoid relapse.

The second case in which I resorted to local medication of the cauda equina was one of "caisson disease," many exquisite examples of which I had the pleasure of studying at St. Francis' Hospital, Jersey City, as well as at Christ Hospital, to which institutions cases of the kind were brought during the construction of the Hudson River tunnel. I will merely mention that, in the case in question, the injection was made with the hope of relieving the severe vesical and abdominal pains which are a peculiarly distressing feature of certain phases of this remarkable disease.

The injection was made in the same manner as in the previous case, but was repeated within the next five hours, as the pain, which was greatly, though not entirely, removed, showed a tendency to return. Within the next forty-eight hours the improvement was, however, so great as to render further local treatment for the alleviation of pain unnecessary.

Since the above cases were reported I have occa-

sionally resorted to the procedure in properly selected cases.

Methods of Treatment Previously Proposed.—Among the older devices which have been resorted to in the treatment of pain originating in the affections of the cord may be mentioned counter-irritation with blisters, or the actual cautery, galvanism, and faradism, hot and cold applications, baths,—Turkish and Russian,—and various internal remedies, which either act directly upon the cord—strychnine, ergot, etc.—or which exert their influence by stupefying the subject—opiates and hypnotics.

To enter into a discussion of these measures would be merely to repeat what has already been said with sufficient explicitness in the chapter on internal remedies.

One of the least philosophical means of dealing with pain is the "suspension treatment," proposed by Motschukowky in 1893, and subsequently endorsed by Charcot. The patient is suspended by the head, the arms assisting somewhat, precisely as though he were about to be enveloped in a plaster-of-Paris jacket. In this condition he is allowed to remain for several minutes. This manipulation may be repeated more or less often as circumstances seem to demand. The pains of locomotor ataxia

and other spinal symptoms are reported to have been relieved by this treatment; and even cerebral disturbances are said to have been abolished by it. Hirt, however, who has used the method one hundred and three times in the same number of patients, states that in no single instance was he able to note any marked or lasting improvement. It has also been proposed to bend ataxic patients over barrels; and one writer, in sheer exuberance of spirit, has suggested that it might be well to "hang them up by the heels." To accept such propositions as this with any degree of seriousness would be to prove one's self devoid of humor. Not even on the score of empirical evidence, much less on theoretical grounds, are such procedures likely to gain a foothold in practice. Indeed, as a matter of fact, the results obtained have been so insignificant that the suspension treatment and its grotesque derivatives have been practically abandoned.

CHAPTER XVII.

THE USE OF COMPRESSED AIR IN CONJUNCTION WITH REMEDIES WHICH TEND TO DIMINISH THE ACUITY OF PERCEPTION.

We have already seen in the course of the previous discussion that the effects of drugs are not only subject to variations dependent upon subjective causes, conventionally spoken of as idiosyncrasies, but are also capable of being greatly modified by extraneous circumstances, among the most important of which are changes in atmospheric pressure. Thus, we have seen that on the summit of a high mountain stimulants act in a different manner than when taken in air condensed beyond that of the normal atmosphere, as we find it, for example, in a diving-bell or in a caisson employed in the construction of submarine works.

It is self-evident that a principle so valuable must be capable of practical application in neuro-therapeutics, as I was the first to point out over two years ago. In a word, stimulants when administered while the subject remains in compressed air are

greatly enhanced in their pharmaco-dynamic effects; and this influence of the air begins to be felt at a pressure of one atmosphere and a half, and is quite pronounced at two atmospheres.

But not only may this be said of stimulants, but also of a number of sedatives, analgesics, and diuretics.

Upon what physiological principle does this phenomenon depend? How is it explicable?

The answer, in a few words, is this:

In the first place, the air pressing upon the surface of the body, and also upon the parenchyma of the lungs,—by way of the bronchial tubes and air-vesicles,—will inevitably cause the blood to gravitate in the direction of the least resistance. Now, as the cerebro-spinal canal is to all practical intents and purposes an unyielding, air-tight tube, the surrounding highly-compressed air is unable to exert pressure upon the contents of the canal,—the brain and cord; and hence the blood will gravitate to these organs,—*i.e.*, in the direction of the least resistance. The result of this will be a notable enhancement of vaso-motor pressure with concomitant increase of exosmosis; so that, if the blood be impregnated with a medicament, the latter will penetrate with greater rapidity than under ordinary circumstances through the cell-wall and into the surrounding parenchyma.

An increase of physiological effect is, of course, the inevitable result of such augmented transudation in the cerebro-spinal structures.

But there is another principle connected with the action of remedies upon the central nervous system which is important both theoretically and practically; I refer to the fact that stimulants and sedatives act much more energetically when caused to linger in the nervous tissues, or, what is the same thing, in the capillaries which supply those tissues. Let me illustrate this point. Some years ago I was called to see a woman—the wife of a hotel clerk—who was a sufferer from neuritis of the brachial nerve, due, probably, to traumatism. The chief seat of irritation was at a point about three inches above the internal condyle of the humerus. Twenty-five grains of antipyrin, with ammonia, were given with a view to arresting the pain, but without avail. Being desirous of avoiding the use of morphine, I passed a ligature around the arm two inches above the seat of pain, tightening it sufficiently to interfere considerably with the venous circulation. At first there was some increase of pain; but gradually it began to decrease, and ultimately—within fifteen minutes—it disappeared entirely, so that the ligature was removed. In this case the ligature was applied nearly three-quarters of an hour after the

administration of the antipyrin by the mouth, so that most, if not all, of the remedy must have been absorbed. The effect of the ligature was to so retard the circulation in the capillaries that the antipyrin contained in the blood was enabled to fully exert its characteristic anæsthetic effects upon the inflamed nerve-filaments.

Now, what is true of the peripheral nerves in this regard is likewise true of the central nervous system. This is shown by the fact that if we administer a remedy like alcohol, and subsequently partially interrupt the flow in the internal jugular veins by compression, the physiological effects of the drug are materially augmented.

From what has been said, it is evident that if we could practically combine these two principles—increased vaso-motor pressure and retardation of the medicated blood-stream in the capillaries of the locality to be most affected—we should be placed in possession of a most potent means of influencing the nervous system, and more especially the brain.

Recognizing the importance of the subject, I have sought to combine these two cardinal principles: first, by exposing the subject in a metal chamber, containing compressed air; and, second, by interrupting the venous circulation in those parts which

it is desired should be brought most fully under the influence of the remedy.

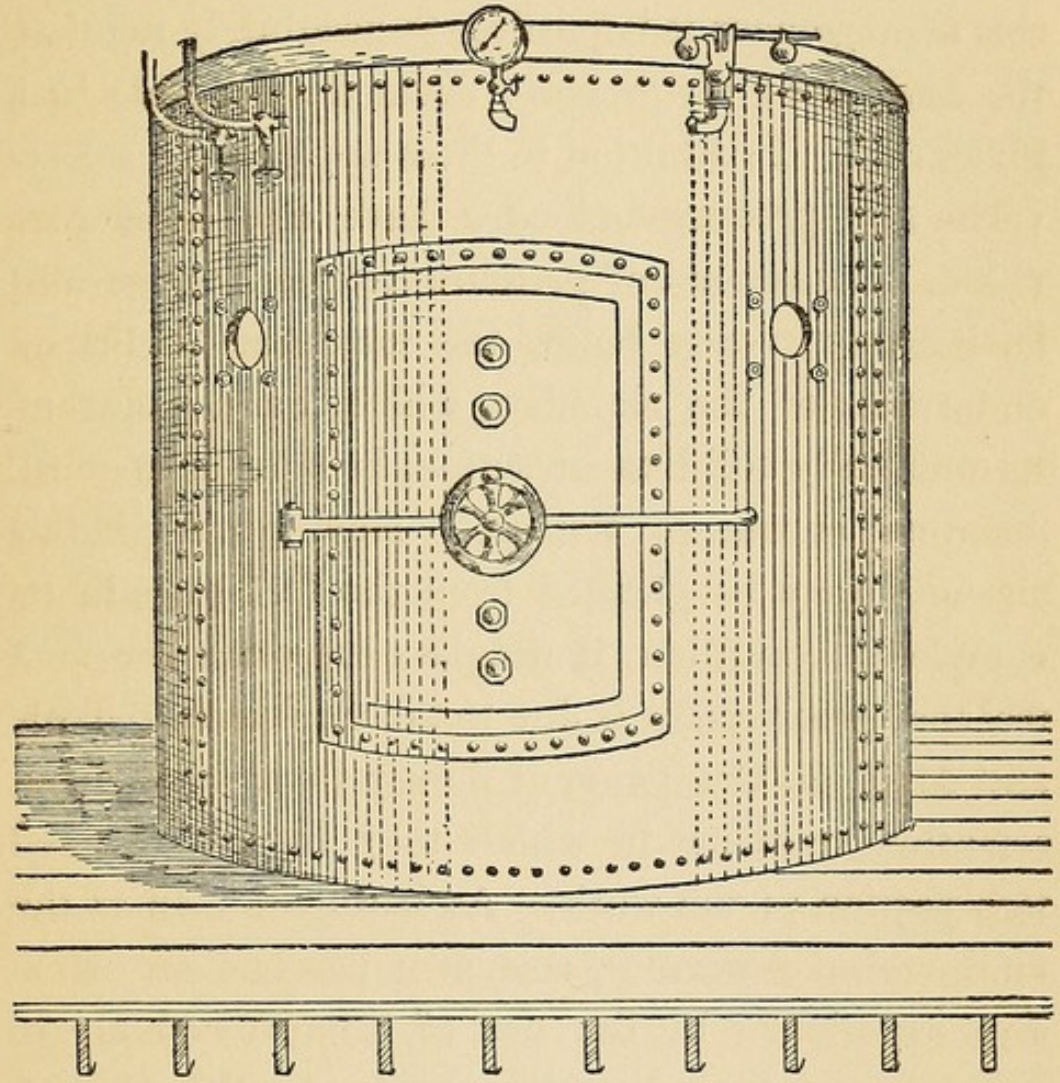
Let me describe in detail the rather elaborate apparatus which I employ in carrying out this plan of treatment; and let me also add that the procedure as here presented differs somewhat from that originally described in the *Medical Record* of August 29, 1891.

The Author's System of using Compressed Air, in Conjunction with Medicinal Solutions, in the Treatment of Cerebro-Spinal Affections of Functional Origin.—In the first place, I have had constructed a large metal chamber, capable of hermetical closure, and able to withstand a pressure equal to that of a locomotive boiler (Fig. 18). This chamber is cylindrical; it is six feet in diameter, six and one-half feet high, and its walls are composed of soft steel. The ends of the cylinder, which compose the top and bottom of the chamber, are five-eighths of an inch in thickness, while the cylindrical walls are somewhat less heavily constructed. The seams are not secured by rivets, but by bolts, so that the chamber was brought into my house in sections, and erected in one of the consulting-rooms without noise or other disturbance.

Access to this chamber is afforded by a massive door, swung from the centre upon ponderous hinges,

which peculiar arrangement admits of a very exact coaptation of the door to its frame. The edges of the latter are, of course, armed with a thick roll of

FIG. 18.



india-rubber. To further insure a hermetical closure an adjustable cross-lever has been provided, so that a screw, acting by the aid of a hinge from the centre of the door upon this lever or cross-bar, enables one

to draw the door—which opens inwardly—firmly against its frame.

The ingress and egress of the air, which is derived from a pump actuated by an electric motor of one horse-power, are regulated by adjustable valves. By this arrangement it is possible to accurately regulate the amount of air-pressure deemed applicable in a given case. In addition to these appliances a safety-valve and pressure-indicator have also been provided. The amount of pressure commonly employed is, however, vastly below the maximum point of endurance of the chamber, which, on account of its unusually solid construction, is capable of withstanding enormous strains. How great is this strength may be gleaned from the fact that, in its completed condition, it weighs over three tons. I feel that great credit is due to the Cockburn Barrow and Machine Company, of Jersey City, for the conscientious manner in which they have performed this portion of the work. As is well known to the engineering fraternity, this firm has had an extensive experience in the use of compressed air in caisson- and tunnel-work, notably, in the case of the Hudson River tunnel and the foundation-work of the Hatteras light-house. It gives me pleasure to acknowledge my special indebtedness to Mr. William C. Barr and Mr. D. B. S. Cockburn, both of

whom have been assiduous in their endeavors to render the mechanical details all that they should be.

I cannot leave this portion of the subject without indicating briefly the principal features of the mechanism employed in condensing the atmosphere within the chamber. For this purpose I have had placed in the cellar of my house a one-horse-power electric motor, actuated by the current derived from the street conduit of the Edison Electric Illuminating Company. To the motor is joined, by appropriate belts and counter-shafting, an air-pump (Fig. 19) of superior construction, and with a capacity of more than one hundred and forty strokes to the minute, the length of each stroke being six inches, and the diameter of the cylinder of the pump being also six inches.

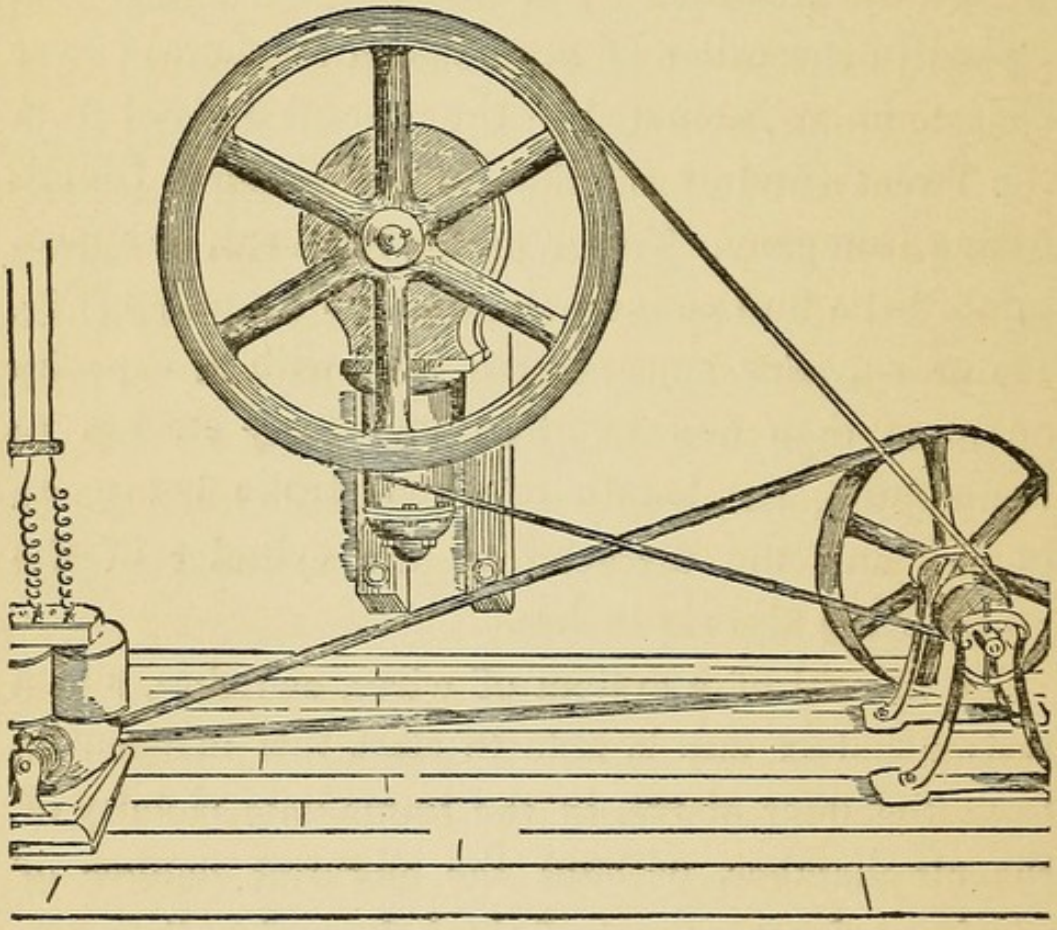
By the aid of a system of wires, switches, and a resistance-box one is able to start this mechanism from the floor above, in the immediate vicinity of the air-chamber, without the slightest danger of causing a derangement of the belts and pulleys employed in joining the pump and motor together.

A strong tube of iron conducts the air from the pump through an aperture in the floor to the metal chamber; while a similar tube affords passage for the redundant air from the automatic exhaust-valve previously described. It is possible, in this way,

to obtain pressures of from fifteen to thirty pounds in a few minutes.

It gives me pleasure to express my indebtedness to Mr. Hadley, of the Edison Electric Illuminating

FIG. 19.



Company, who has superintended this elaborate installation with much diligence and skill.

Let me now describe, in as few words as possible, the manner in which I am accustomed to employ this apparatus, in conjunction with medicinal solutions, for the purpose of increasing and adding

permanency to the pharmaco-dynamic effects of the latter.

For convenience' sake, we may assume that we have to deal with a severe case of the so-called angio-spastic variety of hemicrania,—that form of migraine accompanied by facial pallor which is supposed by some to be the counterpart of partial intracranial anæmia.

Twenty-five grains of antipyrin, with ammonia, have been given the patient, who is suffering acutely; and yet, after the lapse of over three-quarters of an hour,—a period of time amply sufficient to insure absorption,—there is little, if any, relief. At this juncture he is placed upon a couch within the air-chamber, and around his neck is passed a light elastic band, secured behind by an ordinary buckle. The function of the band is to maintain in place, over the jugular veins, two small dry cups. The cups, which are joined together in front by a slotted band provided with a screw, are about two inches long and half an inch wide; they are made of metal,—silver or steel,—and are somewhat concave in an antero-posterior direction, on the open side, which is in immediate contact with the tissues above the veins. On the upper or closed side is a hollow nipple connecting with the interior of the cup. A long, bifurcated, non-collapsable rubber tube joins

these nipples to a small valve in the wall of the air-chamber, by opening which the interiors of both cups are placed in communication with the external atmosphere. For the time being, however, this

Fig. 20.

valve remains shut; the door of the air-chamber is closed; and the air-pump is set in motion. After the lapse of a few moments, the gauge shows that we have eight pounds more pressure in the air-chamber than outside of it, or 15 pounds + 8 pounds = 23 pounds.

The small valve in the side of the air-chamber, which is connected by the bifurcated rubber tube with the dry cups, is then opened, and its immediate result is to place the interiors of the cups in communication with the external atmosphere. As a result of this the pressure inside the cups is only fifteen pounds, while that outside is twenty-three pounds; and the difference between the two, eight pounds, is the amount of pressure exerted upon each square inch of cup, and, consequently, upon the subjacent veins. The effect of the manœuvre is, however, much enhanced by the fact that the tissues of the neck, and, to some extent, the veins also, are drawn in an upward direction by the cups, so that the edges of the latter act energetically upon the lumen of the vessels. The pneumatic jugular compressor, and its use in conjunction with the air-chamber, are well shown in Fig. 20.

In the case of the patient under consideration, the hemicrania disappeared completely after the pressure upon the jugular had been continued five or six minutes; and there remained no other souvenir of its presence than the usual feeling of soreness. Nevertheless, although compression was discontinued, the patient was allowed to remain in the compressed air for another half-hour, as experience has taught me that this is a useful precaution in the

management not only of migraine, but all kinds of intracranial pain due to other than organic changes. Indeed, it is well, when there is reason to fear a recurrence of the pain, to still further increase the air-pressure, say up to two atmospheres; for by so doing it is self-evident that modifications in the cerebral circulation may be attained of sufficient importance to materially modify the morbid conditions. These are not theoretic deductions, but they are rather conclusions at which I have arrived after a vast deal of experience.

A brief synopsis of a few cases in which I have invoked this method of employing compressed air for arresting intracranial pain may not prove uninteresting.

Mrs. N. J. G., age forty-four years, the wife of a distinguished clergyman, was referred to me by Dr. David Webster, over a year ago, on account of intractable head-pain of several years' duration. The pain usually begins over the right eye, and extends backward to the temple, and thence to the right occipital region. More rarely it is also felt over the left eye, but, as a rule, it is hemicranial in type.

Although she has received benefit from the correction of a refractive error (hypermetropic astigmatism) at Dr. Webster's hands, she still suffers at

irregular intervals, even moderate emotional disturbance being sufficient to call forth a paroxysm of great severity. While the seizure lasts, her face is slightly flushed; and, as she is quite thin, the pulsation of the carotids is visible to the eye. She has been under the care of a number of physicians at different times; has been operated upon for laceration of the cervix, without apparent benefit; and has taken a large assortment of internal remedies, likewise without result. Having found no evidence of organic trouble of any kind, I requested her to return at the first intimation of impending pain. Accordingly, five or six days later, she again called, suffering from an attack which had come on during the early morning hours. As a matter of scientific interest I applied pressure to the jugulars,—*but without previous medication*,—as heretofore described, for fifteen minutes, and then, having ceased the compression, she was allowed to remain in the compressed air (of two atmospheres) for upward of three-quarters of an hour. At the end of this time pressure was gradually reduced; and she declared on coming out that she felt relieved, but not wholly so. Accordingly, after allowing her to wait for an hour, I gave her fifteen grains of antipyrin in ammonia,—which she had often tried before, but without success,—applied compression to the jugu-

lars, and had her remain in the compressed air at two atmospheres for an hour. On leaving the chamber at the end of this time she declared that all pain had entirely left her. Her diet having been restricted to poultry, fish, and vegetables easy of digestion, the compressed-air treatment was continued, with the occasional addition of two drachms of the extract of absinthe, as she suffers much from depression.

As a result, there was no pain whatever for nearly a month, so that on April 9, 1892, Dr. Webster wrote me that "she had called to say that she had been much benefited by the compressed-air treatment."

From what I have since seen of her, I am inclined to believe that this benefit has become permanent.

Mr. L. was likewise referred to me by Dr. David Webster on account of "paralysis of his left third nerve," accompanied by persistent headache. There is a distinct history of syphilis, imperfectly treated, so that both symptoms are doubtless of specific origin.

Though he has been treated with large doses of the iodide with considerable benefit, Dr. Webster feels that applications of electricity to the affected muscle should also be tried.

I first saw this patient October 31, 1892; and, on

referring to my case-book, I find that on November 5 I had made five applications of faradism, which had resulted in an abolition of double vision for several hours.

On the same date he was seen by Dr. Webster, who wrote me, "Mr. L. shows marked improvement. When I sent him to you it took 40° base in and 18° base down to correct the deviation. To-day it takes 33° base in and 14° base down over left, a gain of 7° in one direction and 4° in the other."

The headaches, too, had improved under one-hundred-grain doses of the iodide of potash; but he still suffered at times from exacerbations of severe pain. These I was always able to abolish for several hours by the use of fifteen grains of antipyrin, given under an air-pressure of an atmosphere and a half; while the internal jugulars were compressed pneumatically, as in the previous case. The same amount of this drug had been repeatedly given before,—without the use of the compressed air,—and the effect, so far as amelioration of the pain was concerned, was *nil*.

It may readily be imagined that, while the iodide was the principal thing, the compressed-air treatment rendered valuable assistance in a collateral way by relieving the severe pain while the alterative

was doing its work. Eventually, both the head-pains and the diplopia disappeared entirely.

Miss H., referred by Dr. Koplik, was first seen by me May 6, 1893. The doctor writes "that she is a patient suffering from periodic headaches," for which "she has tried many physicians, both in Germany and elsewhere, but found no relief."

Since puberty she has suffered periodically—on an average every five or six days—from these headaches, which, beginning as a dull pain over the left eye, progress to the temple and side of the head, where they usually remain fixed for twelve hours, and then suddenly disappear. They are always accompanied by sickness of the stomach, and occasionally by vomiting. In the beginning they are dull, but later, lancinating in character.

After trying a number of conventional expedients without much success, I determined to endeavor to abolish, or at least mitigate, the seizures by the aid of the compressed air.

Accordingly, she was told to come at once to the office on the first intimation of an attack. This she did in the course of three or four days, the pain being firmly seated, and exceedingly severe at the time of her arrival. As she suffered from nausea, she was given one-fourth grain of cocaine in a teaspoonful of water to which ten grains of the bicar-

bonate of soda were added. This seemed to relieve the nausea considerably, so that in half an hour it was possible to proceed with treatment. Fifteen grains of salipyrin were given her, and half an hour afterwards she entered the air-chamber, where compression of the jugulars was carried out, as in the previous cases, for fifteen or twenty minutes. The compressor was then removed (by the patient), and the air condensed to two atmospheres, at which point it was maintained for an hour. Pressure was then gradually reduced, and the patient removed from the chamber. She then declared that shortly after the compression of the jugulars the pain had been much relieved in severity, and at the time of leaving the chamber it had been entirely abolished.

This was the most severe attack which she experienced while under my observations. Ultimately they seemed to lose their vehemence to such a degree that I am confident proper attention to diet and the occasional use of simple remedies will do much for her.

In view of this amelioration in the severity of the attacks, which is even more marked in some other cases which I have seen, I cannot repress the conviction that the air itself, through its influence on the circulation in the interior of the body, must tend to readjust—for I can find no better word—

any nutritive disturbances of a local character in the cerebral organs or their appendages. Certainly the simple drug alone could hardly be expected to accomplish so much. The hyperdistention of the capillaries in the cerebro-spinal organs, consequent upon the increased vaso-motor tension during treatment, has doubtless much to do with this continued improvement.

These are fair examples, then, of the way in which remedies may be made to concentrate their effects upon the intracranial structures. In all but very fleshy persons the method is readily applicable; but when the adipose covering of the neck is very dense it is impossible to act upon the internal jugulars with any degree of certainty, and without great inconvenience to the patient.

In conclusion, let me add that the chief field of usefulness of the method is in the management of intracranial pain of a severe type. When it is a question of dealing with head-pain, combined with spinal symptoms, as often enough happens, or with melancholia or neurasthenia, the procedure originally advocated by me in 1891 should be invoked.

As completeness of the argument demands a presentation of this system of affecting the cerebro-spinal axis, I shall proceed to describe it as briefly as possible.

Showing how Compressed Air may be used to Advantage where it is desired to Focalize the Action of Remedies upon the Entire Cerebro-Spinal Axis—Application of the Principle of Exclusion.—In carrying out the exigencies of this problem we are obliged to invoke a somewhat different principle than when it is desired to concentrate the action of remedies upon the brain: to put it succinctly, we cannot compress the medullary veins, and hence we are obliged to resort to *exclusion*,—*i.e.*, cut off certain portions of the economy, such as the limbs, from the field of activity of the remedy. This we may do by the application of ligatures to the extremities. Let us examine somewhat more closely the principle of action with which we are here confronted.

In the first place, it must be remembered that the amount of ether, chloroform, chloral hydrate, the bromides, strychnine, and many other remedies required to produce physiological effects upon the cerebro-spinal mechanism, may be reduced by first securing a ligature around the central portion of one or several of the limbs of an animal, so as to interrupt both the arterial and the venous circulation.

The proof and explanation of this may be thus presented:

In the first place, it is well known that children and small animals are affected by much smaller quantities of anæsthetics and other medicinal substances than are required to produce equal effects in men and large animals.

At first sight there appears to exist a certain definite relation between the weight of the animal and the quantity of medicament required to produce physiological effects. On closer inquiry, however, we find behind this proposition the deeper truth that the *real proportion is between the magnitude of the blood-mass and the amount of medicament.* Thus, if we withdraw a considerable amount of blood from a large dog, we may be able to influence him by much smaller doses than those required under ordinary circumstances; and, among human beings, we find the anæmic much more susceptible to remedies than the full-blooded of equal weight. The degree of saturation of the blood-mass with the remedy is obviously, then, the principal thing; the greater the amount of blood, the more remedy—everything else being equal—we shall have to give in order to obtain definite results.

If we wish to embody the proposition in a mathematical statement, we may do so in the following simple manner:

Let *a* represent the total quantity of blood, *b* the

amount of remedy exhibited, and x the magnitude of the physiological effect. We shall then have the simple formula $x = \frac{b}{a}$.

Again, if we withdraw a certain quantity of blood from the circulation by venesection, and call that amount d, we shall then have the formula $x = \frac{b}{a - d}$. But, if we wish to act upon the organs of the trunk, and more especially upon those contained within the cerebro-spinal canal, it is not necessary to resort to such a drastic expedient as copious blood-letting; for, in place of this, we may dam up and effectually eliminate from the rest of the body a certain amount of blood by passing a ligature around the central portion of one or several extremities, so as to interrupt the circulation in both artery and vein. When this has been done, it is clear that we may introduce a remedy into the system by way of the stomach, or hypodermically into some portion of the trunk; and it is equally certain that a remedy so introduced will be diluted only in the ratio of the amount of blood freely circulating, and more especially by that contained within the trunk and head. That which is incarcerated behind the ligatures is as effectually withdrawn from the realm of physiological action as though it had been abstracted by the surgeon's

knife. Elimination by the knife and elimination by the ligature are, for present purposes, then, one and the same thing. Hence, if we let d' represent the amount of blood incarcerated behind the ligatures, x the magnitude of the physiological effect, which we are seeking, b the amount of remedy exhibited, and a the total amount of blood contained in the whole organism, we shall have the formula

$$x = \frac{b}{a - d'} = \frac{b}{a - d}.$$

Several years since I had an excellent opportunity of proving the truth of the foregoing, in connection with the administration of ether, in the case of a patient who resisted all attempts to anæsthetize him in the ordinary way.

The case in question was a man under treatment at the Manhattan Eye and Ear Hospital, upon whom it was deemed advisable to perform an operation. As has been said, the ordinary means of inducing anæsthesia had proven ineffectual, for the man was a confirmed drunkard; and it was at this juncture that I was called in consultation, and requested by my friend Dr. David Webster, one of the surgeons of the hospital, to endeavor to devise some means of getting the man under the influence of the anæsthetic.

The procedure which I suggested was this:

Around the upper part of each thigh a flat rubber tourniquet was tightly drawn, and secured in place in the usual manner. By this means the sequestration of all the blood contained in the lower limbs was accomplished; but, inasmuch as both artery and vein were compressed, only the amount of blood usually contained in each limb was shut off from the rest of the body,—which would not have been the case had we contented ourselves with merely compressing the veins, as some have done.[1] In subsequently commenting on my published report of this case, that most accomplished writer and physician, Henry M. Lyman,—than whom there is no greater authority on anæsthesia,—observes that the plan proposed and adopted by me on this occasion (that of compressing both vein and artery) is far preferable to compression of the vein alone.

The reason for this is not far to seek. When we compress the veins alone there is a rapid accumulation of blood in the extremities, through the accessions derived from the uninterrupted arteries. Now, as this blood is derived from the trunk, and,

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[1] "On the Effective and Rapid Induction of General Anæsthesia," the New York Medical Journal, October 22 and December 24, 1887.

consequently, also from the organs contained within the cerebro-spinal canal, there is danger of syncope, and even heart-failure. When, on the other hand, both artery and vein are compressed no such derivative action occurs, and all danger is consequently removed. With an apology for this brief digression, I now return to the interesting case which has given rise to it.

Having, as previously stated, applied tourniquets to the central portion of the lower limbs, the ether-cap was placed over the mouth and nose of the patient, and in an incredibly short time he was unconscious, and the surgeons were able to go on with the operation.

The late Dr. Cornelius R. Agnew and many other members of the staff of the hospital were present, and gave emphatic expressions of approval.

Dr. F. W. Ring, assistant surgeon to the Manhattan Eye and Ear Hospital, declared that both the amount of ether and the time consumed in its administration were infinitesimal, when compared with what had been expended in previous efforts at inducing anæsthesia in the usual way. The facts brought out on this occasion with regard to the administration of ether have since been repeatedly verified by different observers; so that at the present day their validity cannot be questioned. I

desire to add, however, that I have long known that the dosage of phenacetin, antipyrin, morphine, chloralamid, chloral, the bromides, and many other remedies might be reduced by resort to the same procedure; all of which is merely equivalent to stating that their pharmaco-dynamic energy may be increased in this way.

The reduction of the amount of blood to be impregnated with the remedy, by the application of ligatures to the extremities, and the concurrent exposure of the subject to the influence of compressed air, so as to increase the vaso-motor tension of the medicated regions,—*i.e.*, interior of trunk and cerebro-spinal canal,—constitute, then, the essential features of this plan of medication. By invoking its aid melancholia, the lassitude of neurasthenia, and pains of an ambulatory character, as well as those of definite spinal or cerebro-spinal type, may be treated with an effectiveness attainable in no other way.

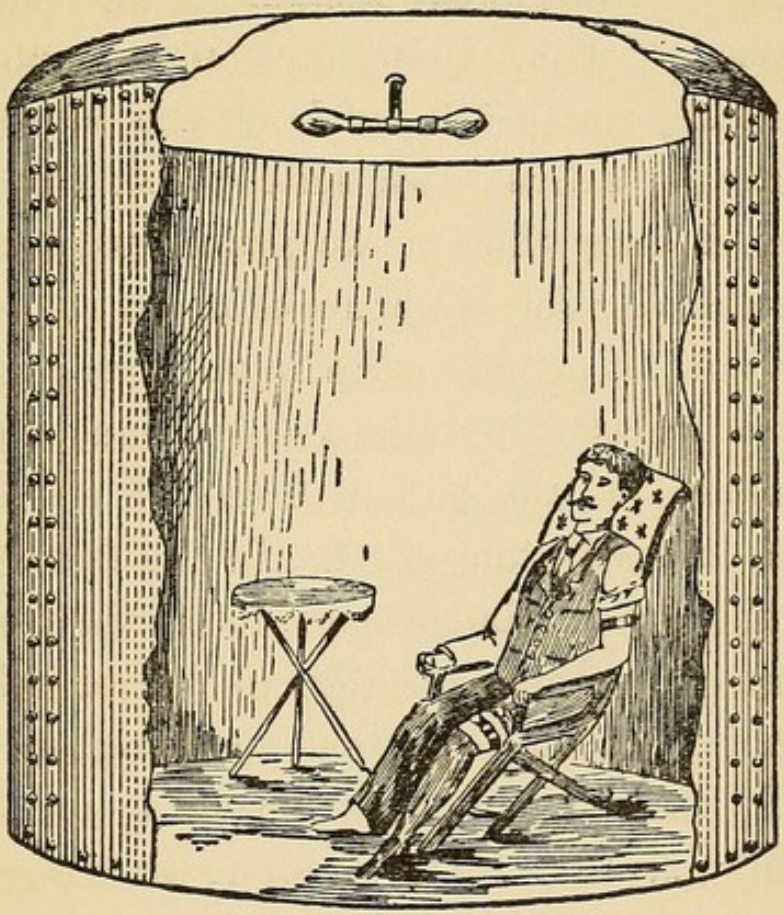
Let me now describe, in as few words as possible, the manner in which I am accustomed to employ this apparatus, in conjunction with medicinal solutions, for the purpose of increasing their pharmaco-dynamic effects, more especially as related to the cerebro-spinal functions.

As stated at the beginning of the argument,

I esteem it of advantage, before introducing the remedy into the system, to sequestrate a certain amount of blood in one or more of the extremities. This may be done by passing a ligature around the limb so as to arrest the circulation in both artery and vein; or the ligature may be drawn only sufficiently tight to check the circulation in the cutaneous veins alone. While in the latter case the ligature is much better borne than in the former, so that it may be worn for protracted periods without inconvenience, it possesses the inconvenience that it causes an abnormal accumulation of blood in the extremity, with consequent inordinate exsanguination of the trunk, and hence of the spinal cord and brain. To avoid this depleting influence, however, it is only necessary to have the patient apply a moderately tight bandage, in the form of an elastic stocking or sleeve (when the ligatures are applied to the arms), before adjusting the ligature (Fig. 21). In this way stasis of the blood circulating in the veins may be obtained without depleting to any considerable extent the brain or cord, and without special inconvenience to the patient, provided that the elastic stocking or bandage has been applied in such a way as not to compress the veins, but merely to limit their expansion. This point I hope to have made sufficiently intelligible. The ligatures having

been applied, and the medicinal solution administered,—either by the mouth, rectum, or hypodermically,—the patient enters the pneumatic chamber, the air-pump is set in motion, and by degrees the

FIG. 21.



condensation of the atmosphere progresses until the desired pressure is obtained. When this point is reached the redundant air passes off through the blow-off valve, which, as previously mentioned, is automatic in its action, and readily adjustable to any desired pressure.

I have rarely deemed it necessary to employ greater pressure than thirty pounds to the square inch (two atmospheres), and I often employ lower ones, especially when the delicate state of the patient's health seems to demand such a course. How long should the patient remain in the condensed atmosphere? This question cannot be answered dogmatically: as a rule, an hour will be sufficient to insure an active therapeutic effect; but, exceptionally, I have allowed the patient to remain in the air-chamber for two hours or more.

And now let me add a few injunctions respecting the precautions to be observed in connection with the removal of the patient from the air-chamber into the normal atmosphere. In the first place, it is of the utmost importance that this transition from an atmosphere of high to one of relatively low tension should be gradually accomplished. To this end the air should be allowed to escape very gradually, so that from fifteen to twenty minutes are consumed in the operation of reducing the pressure in the chamber to that of the external atmosphere. While the reduction of pressure is in progress the tourniquet or straps employed in compressing the vessels are removed, but the elastic stockings (or bandages) are allowed to remain.

It is also sometimes advisable to have the subject swallow thirty drops of spiritus ammoniæ aromaticus, in water, at this time; for, as the pressure decreases, there is always a diminution in the energy and number of the heart-beats.

This cardiac stimulant stands properly prepared upon a table in the air-chamber, and the patient is instructed beforehand when and how to take it. The combined effect of the elastic compress and the cardiac tonic is to increase the vaso-motor pressure in the cerebro-spinal system of vessels at the very moment when the compressed air is ceasing to perform that function. As a result of these precautions I have yet to meet with a single untoward effect from this system of treatment.

Finally, the ventilation in the air-chamber should be carefully looked to, so as to avoid the inordinate accumulation of carbonic acid gas in the chamber, and hence in the system; for when the tissues—and more especially those of the cerebro-spinal system—are overloaded with carbonic acid, grave disturbances of function may be induced, which manifest themselves after the subject leaves the compressed atmosphere. It is ignorance or disregard of this fact, in connection with submarine work, which has, I believe, given rise to many cases of severe caisson disease.

In the elaborate and roomy apparatus which I employ there is fortunately no danger of this or any other kind of accident, since the circulation of air is continuous, and the pressure capable of exact and automatic regulation.

The next question which naturally suggests itself is, "What are the remedies most suitable to be administered under pressure, where a direct action upon the nervous system, and especially the cerebro-spinal system, is sought after?" This question has already been referred to at the beginning of this chapter, but I should like to answer it somewhat more explicitly. In the first place, all chemicals which possess an affinity for nervous matter, as revealed by their ability to modify the functions of the central and peripheral nervous system, more especially the former, may be given with advantage while the subject remains in a condensed atmosphere. When I say that such substances may be given with advantage in this way, I mean that the intensity and permanency of their effects may be thus enhanced; or, in other words, they may be given with equal if not greater effect in much smaller doses, and the benefit derived lasts much longer.

A moment's reflection will suffice to convince any thoughtful physician of the significance and magni-

tude of these things from a practical point of view. It is, indeed, at once apparent that the discovery is capable of a wide application in the treatment of nervous derangements, especially those involving the brain or cord, or both. I have said that the remedies may be given hypodermically, by the mouth, or per rectum. I may add, however, that their exhibition by the mouth, dissolved in some diffusible stimulant of an alcoholic nature, is to be commended.

Illustrative Cases.—A brief synopsis of a few of the cases in which I have resorted to this system of treatment will best serve to give an idea of its effectiveness and wide applicability.

Case I. *Pain due to Morbid Irritability of the Cord; Spinal Irritation.*—Miss C., aged forty-five, had been treated by a number of physicians for obstinate dorsal and intercostal pain. The cautery, galvanism, and all the usual drugs, including strychnine, had been tried without avail. She was brought to my consulting-room by one of my former patients, whom I had been fortunate enough to cure of obstinate headaches.

On physical examination I found the spine tender on pressure in the cervical, dorsal, and lumbar regions; while such paræsthesiæ as tingling, numbness, and "burning" pains were promptly evoked

when she attempted to walk or bend the trunk forward or laterally.

These symptoms had manifested themselves more or less constantly for the past three years; but there was no evidence of any organic alteration involving the nervous system. The pulse was somewhat sluggish, but the heart and lungs and the kidneys were healthy.

While the interview was still in progress she complained of feeling a great deal of pain, and wishing, if possible, to afford her some relief, I gave her twenty grains of antipyrin in a teaspoonful of the aromatic spirits of ammonia, well diluted with water. Although she was somewhat anæmic, there was no unpleasant symptom; but, unfortunately, neither was there the slightest relief, the pain persisting as energetically as before.

On the following morning she was again brought to my office in a carriage. Learning that she still suffered from the painful paroxysm of the day before, I gave her ten grains of antipyrin in a little alcohol, applied two ligatures above the knees, and then installed her upon a comfortable couch within the air-chamber. During the first fifteen minutes the pressure reached eight or ten pounds to the square inch. Subsequently it was increased to twenty-five pounds, which point it was not allowed

to pass, the blow-off valve being adjusted to that purpose. After remaining in the condensed atmosphere for three-quarters of an hour, the pressure was gradually reduced; and fifteen minutes later, the equilibrium between the air in the chamber and the external atmosphere being established, she rose from the couch and passed through the open door without assistance. She then stated to me in the most positive manner that not only was she now quite free from all discomfort, but that she had been quite relieved of pain after the first fifteen or twenty minutes of her sojourn in the condensed atmosphere.

There being no considerable return of pain the following day, treatment was continued as before, except that one-twentieth grain of the sulphate of strychnine was given hypodermically, instead of the antipyrin, before entering the condensed atmosphere. She was also placed upon the albuminate of iron and quinine, both of which she took for some time after the principal meal.

At the end of three weeks, there being no return of pain, she was allowed to discontinue treatment. Quite a long time has elapsed since then, but she writes me that she is quite well, and has gained considerably in weight.

CASE II. *A Case of Nervous Headache promptly*

relieved.—This case is cited merely to show how promptly a distressing phase of headache may be relieved by this plan of treatment, with a minimum of drugging.

Mrs. D. E., a married lady forty years of age, has suffered from severe attacks of headache of a "nervous" type for many years. As a rule, the paroxysm begins with more or less visual disturbance, the sight becoming clouded; and all attempts to use the eyes are followed by marked feelings of discomfort in the eyes and head. Nevertheless, there are no tangible ocular defects; the pain is not located in the eyeballs, but is ambulatory, predominating at times in the occipital region, at others in the forehead. The circulatory disturbances are inconsiderable, and do not merit special attention, either from an etiological or therapeutic point of view.

Although all the usual remedies have been tried, she has, until within the past six months, derived the greatest benefit from the use of the bromides. For some time, however, these have failed to abort the attacks of pain, so that she now refuses to further continue their use.

By dint of some persuasion, I finally induced her to take something less than her usual dose of the bromide of potassium, the constricting ligatures

being first placed above the knee and elbow, and the elastic stockings being just tight enough to prevent inordinate distention of the vessels. In this way a very complete stasis of the circulation in the superficial veins of all four extremities was obtained; so that the amount of blood sequestrated, and hence uncontaminated by the drug, must have been considerable. On the other hand, the elastic stockings served to prevent any appreciable exsanguination of the cerebro-spinal axis or the trunk as a whole, as was shown by the carotid pulse remaining unaltered.

Twenty minutes after taking the remedy the patient declared that she was no better. She was then placed in the air-chamber, and the pressure increased to fifteen pounds to the square inch, at which point it was maintained for nearly half an hour. The pressure was then gradually reduced, as she intimated that the pain had entirely left her.

Case III. *A Case showing that the Effects of Alcohol may be greatly enhanced by exposing the Subject in a Condensed Atmosphere.*—R. E. A., a young unmarried man, has been addicted to the habitual abuse of alcohol for many years. He states that at the present time he is obliged to take double the quantity which he formerly drank in order to obtain the slightest stimulating effect. I had him indicate

on a tumbler his usual dose; and, as there exhibited, it could not have been less than two ounces, his tipple being whiskey or brandy. Wishing to ascertain whether in so old an habitué the compressed air might be invoked as an aid to decreasing the amount of alcohol taken at one time, I gave him half his accustomed dose of whiskey, and had him enter the air-chamber (without ligatures or elastic stockings). The pressure was then gradually increased to eighteen pounds to the square inch, and at this point it was maintained for twenty minutes, the air being renewed from time to time to insure a plentiful supply of oxygen. It was then gradually decreased till the pressure within the chamber equalled that of the external atmosphere. The door was now opened, the patient having been exposed to the influence of the condensed atmosphere for forty-five minutes, and to a maximum pressure of eighteen pounds for twenty minutes. He then stated that he was certain that the degree of exhilaration experienced was quite equal, if not greater, in degree to that usually derived from twice or even thrice the quantity of alcohol exhibited under ordinary circumstances.

The capital significance of such an observation as the foregoing will, I am sure, impress itself upon every thoughtful practitioner.

CASE IV. *A Case showing the Beneficial Influence of this System of Treatment in Simple Melancholia (without Delusions).*—A. S. E., young girl, aged eighteen, has suffered for the past few months from hysterical attacks, followed by periods of marked depression. She has neither hallucinations nor delusions, but she is irritable and obstinate, and at times difficult to control. Of late she has lost considerable flesh, her bowels are constipated, and, in fact, her whole physical condition is far from satisfactory.

Recognizing the paramount necessity of improving the general bodily state, I have had her drink warm milk,—often as much as four or five tumblers a day; I have given her, in addition, both cathartics and diuretics; and I have sought to have her take more air and exercise, at the same time endeavoring to promote sleep by the conservative exhibition of soporifics.

These things have already begun to do good; but, while she is more tractable and less inclined to cause worry to those about her, her attacks of depression, though perhaps not as frequent, are quite as severe as formerly. While suffering from one of these attacks of depression she was recently brought to my office by her mother; and, at my suggestion, she was placed in the air-chamber, a small dose of

the extract of absinthe and brandy having previously been given her.

In a short time the pressure was shown by the indicator to be fifteen pounds, and at this point it was maintained for twenty minutes or more. After the lapse of this period a marked change took place in the patient's appearance, as could readily be ascertained by looking through one of the large glass port-holes. Her face, which had previously worn a dejected, indifferent appearance, now displayed a contented and even happy expression, and she occupied herself with reading the newspaper, —something that she had not done before for weeks.

On leaving the air-chamber this air of contentment remained, and, according to her mother's statement, she showed no further evidences of depression for the next three days.

Though I had employed the above remedies, and various others as well (without the compressed air), on former occasions and in larger doses, it had never been my good fortune to obtain any appreciable immediate good from them. I feel, therefore, entirely convinced—more especially as I have since been able to produce the same class of effects over and over again, both in this and other patients—that the enhanced potency of the drugs was entirely

due to the concomitant influence of the compressed air.

CASE V. *A Case showing the Enhancement of the Soporific Powers of Hypnotics, and more especially of Chloralamid, by the Administration of the same while the Subject remains in a Highly-Condensed Atmosphere.* —E. N., a neurasthenic woman who has suffered from acute insomnia for several weeks, and who is inappreciably influenced by the usual hypnotics or their combinations, even when given in large doses.

Among other soporifics I have given her chloralamid in doses of forty-five grains, but with quite insignificant success; for in spite of the remedy she declares that she never sleeps more than one hour or two out of the twenty-four. At my suggestion she consented to try the effects of the compressed-air treatment.

Accordingly, I gave her a dose of thirty grains of choralamid,—fifteen grains less than she had previously taken at night; and fifteen or twenty minutes after its administration—the elastic straps having been previously adjusted to the lower extremities, above the knees—she entered the air-chamber. The pressure was then raised to fifteen pounds to the square inch, as shown by the gauge; and at this point it was maintained for upward of half an hour, the air being renewed from time to time, but without

altering the pressure. While thus exposed to the concomitant influence of the drug and condensed air she became drowsy, and finally fell asleep. From this state of unconsciousness she was only aroused by the noise of the escaping air as I opened the valve of the outlet-tube in order to empty the chamber.

On the following day she stated that at the conclusion of the treatment she had gone home, and, lying down upon the lounge, had immediately fallen asleep, only awaking after the lapse of five or six hours. In other words, she had slept the entire afternoon,—something that she was quite unable to accomplish even previous to the attack of insomnia.

This case is instructive, as exhibiting the continued good effects of this plan of treatment; by which I mean that the soporific tendency persists even after removal of the patient from the condensed atmosphere. I will merely add that this case went on to complete recovery, natural sleep supervening regularly, without artificial assistance of any kind, after treatment had been continued for four weeks.

Case VI. *Showing the Arrest of the Painful Crises of Locomotor Ataxia by the Compressed-Air Treatment.* —One of the most effective applications of the compressed-air treatment is in the arrest of the periodic attacks of pain so characteristic of tabes dorsalis.

A good illustration of this is afforded by a gentleman who has been a sufferer from ataxia nearly five years, and who has been under my own observation more or less during the last three years. He exhibits the pupillary and sensory phenomena peculiar to the disease; but the incoördination, though pronounced, does not as yet give rise to serious disturbance of locomotion. On the other hand, he suffers from periodic attacks of pain of great severity in both arms and legs, as well as about the chest ("girdling" pains). A crisis of this kind usually occurs about once in six or eight weeks, and lasts—if allowed to run its course—from thirty-six to forty-eight hours. For the purpose of mitigating these attacks he has invoked every species of medication, including morphine, which he has had to abandon on account of marked idiosyncrasy.

Recently, on the advice of the late Dr. Charcot, of Paris, he has taken antipyrin in large quantities, frequently, indeed, in doses of forty grains. It is true that these enormous doses of the drug controlled the pain; but they accomplished this at the expense of the heart-beat, which suffered gradual but distinct impairment of vigor.

Being desirous of reducing these monstrous doses, the detrimental influence of which on digestion and the heart's action he recognized, I proposed that

we should endeavor to reënforce the action of the analgesic by the aid of the compressed air. He consented immediately; and accordingly, on the next appearance of pains, a week or ten days later, he repaired to my consulting-room at once.

Twenty grains of antipyrin—half the former dose—were then given him, combined with a drachm of the aromatic spirits of ammonia, and shortly afterwards he entered the air-chamber, where he remained for upward of an hour. During this time the air-pressure was maintained at two and a half atmospheres. After the lapse of twenty minutes he wrote on a piece of paper, which he displayed before the window of the chamber, that he was "feeling much better," and, fifteen minutes later, that the pains had disappeared.

In fact, on leaving the chamber, twenty-five minutes later, he declared in the most emphatic manner that he was more relieved by the compressed-air treatment, with reduced doses, than by the enormous quantities (forty grains) of antipyrin which he had formerly been addicted to. Though the pains seemed to be completely aborted,—there being no return during the succeeding twenty-four hours,—he insisted, nevertheless, on taking the same treatment the following day, fearing, as he said, that the pain "might not forget to stay away." This

precaution was perhaps not altogether superfluous, for, as has previously been said, the painful crisis generally persists thirty-six or forty-eight hours. Whether this second séance in the air-chamber was really necessary or not is, however, of little moment, the chief point of interest being that we were able to effectually abort the attack with a minimum of drugging. Another interesting feature is the fact that the next attack was much delayed in its appearance, three months having elapsed before the advent of the first darting pains.

This, of course, may have been a coincidence only; and I was careful to so inform the patient, who seemed inclined to ascribe too much importance to it.

I must say, however, that this element of improvement continues; for, since the first successful attempt to relieve him, he has always insisted on coming for the same purpose, as soon as the characteristic sensations are felt; but the intervals between the attacks of pain are increasing in length.

Since the publication of some of these cases in the *Medical Record* of August 29, 1891, I have treated over two hundred other cases, involving the use of the compressed air more than three thousand times. Though the pressure was occasionally carried up to three atmospheres, and generally to

two atmospheres, I have never had the slightest approach to an accident. This exemption from all unpleasant consequences I ascribe to two circumstances: first of all, to the excellent ventilation; and, secondly, to the invariable habit of allowing the air to escape quite gradually. As at present arranged, it is possible for the patient to let himself out of the air-chamber at any time, without external help of any kind. This fact tends, of course, to give him a feeling of perfect personal security, all that is required on his part being the simple opening of a valve inside the chamber, which in turn allows the escape of the air and the opening of the door, the *latter being allowed to remain unfastened*, the compressed air being itself sufficient to insure hermetical closure.

All that has been said of compressed air in this chapter is confirmed, and more than confirmed, by the experience of those populations who are obliged, as in bridge- and tunnel-building, to work under unusual atmospheric pressures. So convinced are many of these persons by actual experience of the power of compressed air to augment the action of stimulants, that they vastly prefer to take their coffee and alcohol in the condensed atmosphere; and, in order to attain their end, they do not hesitate to conceal these articles in bottles and smuggle

them into the delectable region, in spite of all rules to the contrary. I myself have seen the entire floor of extensive submarine workings covered with such bottles, and have had abundant occasion to hear from the lips of scores of workmen corroborative testimony as to this remarkable phenomenon. It was, indeed, the study of the habits and experiences of these submarine workers which led me to an appreciation of the importance of compressed air as a means of treating a variety of functional derangements of cerebro-spinal origin.

Finally, certain definite effects are obtainable from compressed air without the concomitant assistance of remedies of any kind; and to this circumstance some of the more permanent good derivable from this agent is possibly attributable.

As space does not permit of pursuing the subject further, I must refer those who are sufficiently interested to my original paper in the *Medical Record*, which has already been several times referred to.

Limitations of the Method.—Nothing in the world is more unwise than to claim too much for a new departure in therapeutics, however worthily conceived; for the exaggeration at once overshadows the good in it, and the result is immediate condemnation and the loss to science of what would

have proven a valuable expedient had its field of legitimate action been accurately determined.

This danger I am resolved to overcome by absolute openness of statement.

In the first place, then, the compressed-air treatment, as previously described, is of no use whatever in the management of the inflammatory and degenerative conditions of the spinal cord or its membranes. I have tried it in disseminated sclerosis, in spastic spinal paralysis, in poliomyelitis, with purely negative results. In cerebral hemiplegia its use is absolutely contraindicated; and the same may be said of articular rheumatism, the pains of which are increased by air-pressure. Nor is neuritis a disease which lends itself to this mode of treatment, the increased pressure at the surface serving rather to augment than to diminish the pain.

What, then, are the affections to which the compressed-air treatment, as previously described, is best adapted? Speaking generally, it may be said that cerebral and cerebro-spinal difficulties of a functional character, in which pain, exhaustion, insomnia, or depression are prominent features, are the most suited to this plan of treatment. Indeed, I have no hesitancy in saying that in the management of the last-named class of affections it is absolutely unapproachable. The cases already cited and

commented upon, as well as the immutable physiology involved in the method, will, I trust, have carried conviction on this point. I would observe, however, that, did the space available permit, I could multiply the clinical evidence tenfold.

In conclusion, let me add that not the least interesting influence of the compressed air is its ability to greatly enhance the effects of diuretics, a quality which is especially conspicuous in the case of coffee and diuretine.

CHAPTER XVIII.

REFLEX AND SPURIOUS OR IMAGINARY PAINS—HYPNOTISM.

"Reflex" Pain.—Within the last few years a great deal has been said and written regarding a class of pains which, while originating at the periphery, are referred to some other locality, and, notably, the central nervous system. The backaches which so frequently accompany uterine displacements, and the headaches consecutive to eye-strain, are instances in point.

It is not always, however, an easy matter to decide whether a painful sensation is due to a local cause or is traceable to some distant source. This is especially true of certain intracranial pains, the association or non-association of which with a local cause cannot be determined—if inspection were indeed of any value—on account of the inaccessibility of the parts. What, then, are the maxims to be observed when pain exists, in the absence of neuritis or other common cause, and when there is no evidence of autointoxication of any kind? The reasonable reply I believe to be this: Remove all

ascertainable causes of peripheral irritation, where the mutilation or danger to life is not great; for, even though the sequel may prove that the pain was not of reflex origin, it is certain that had the irritative element been allowed to remain its presence would have interfered with and possibly entirely neutralized all our efforts to obtain relief in other ways. Let me again repeat, however, by way of qualification, that this is the logical course to pursue when neither the life of the patient nor extensive mutilation is concerned. Only pain of the greatest atrocity, which has resisted all other means to relieve it, and which is clearly the result of the peripheral difficulty, can justify measures involving great peril to life.

But when we have said this we have sufficiently indicated the course which a reasonable conservatism may dictate; and we shall carefully abstain from wholesale condemnation of the efforts of gynæcologists, ophthalmologists, and other surgeons to render the removal of peripheral sources of irritation more certain; for such condemnation, though originally in part justified by some very obvious exaggerations, has been carried to an extreme which is alike at variance with the facts and the canons of good taste.

For my own part, I am free to confess that I

have long made it a practice to have all sources of peripheral irritation eliminated, as far as possible, in those who come under my care for pain, or, indeed, for any kind of nervous trouble. My experience has, in fact, taught me that such peripheral disturbances—though they may not always be, and, indeed, frequently enough are not, the real source of the trouble—possess the quality of interfering with, and even absolutely neutralizing, everything that may otherwise be done for the patient.

This applies in an exceptional degree to anomalies of refraction, which are often the source, and, if not the source, then the perpetuating factor of various head-pains. Dr. David Webster has lately written with great lucidity and conservatism on this point.

Spurious or Imaginary Pains.—When a person has long been the victim of more or less continuous pain of either a local or general character, but more especially the former, it inevitably follows that the mind gradually assumes an anticipatory attitude towards the unpleasant feeling; so that, even when the latter is temporarily absent, the "concept" pain still haunts the mind, and the patient believes that he suffers. The foundation of these delusions is substantially that of the analogous phenomena exhibited by hypnotism,—to wit, expectant attention awakened by the continual repetition of the un-

pleasant sensation. Hysterical and imaginative persons are especially prone to become victims of this subjective kind of pain; and it is interesting to note that they are likewise amenable to hypnotic influence. While it is of importance, as may readily be imagined, to determine, in a given case, whether the pains be really objective or purely of subjective origin, it must not be forgotten that, in so far as the sufferings of the individual are concerned, one variety is about as bad as the other. Hence violent and mandatory conduct on the part of the physician is to be discouraged, as being both unscientific and inhuman.

Powerful moral influence, coupled with adroit suggestions of an opposing character,—the attention of the subject being meanwhile directed away from the imaginary seat of pain,—will be found to yield the best results. All this can generally be accomplished while the patient remains in his usual waking condition, and without invoking the aid of hypnotism, the induction of which is often beset with great difficulty, and is, in a considerable percentage of cases, quite impossible. Concerning the dangers of hypnotism, as well as the therapeutic uses to which this agent might possibly be put, I have expressed some opinions which, though rather pessimistic, are, I believe, strictly in accordance with

the facts.[1] The following observations are taken from my original paper:

Possible Dangers of Hypnotism.—As long ago as 1784 some of the dangers of hypnotism were pointed out by De Puységur, a pupil of Mesmer. The danger to which he referred more particularly was the criminal use which an unprincipled person might make of the ascendency gained over the subject. These warnings, frequently repeated of late, are not without reason, as the annals of crimes committed during the last sixty years abundantly prove. Rape, kidnapping, and murder are some of the crimes charged to the account of the nefarious hypnotizer.

But these are not the only sources of danger; for experience has abundantly shown that the subject himself may be prompted to commit theft and other species of crime after emerging from the hypnotic condition. This fact, which has already been mentioned, has become the subject of special judicial enactment in several countries.

Finally, the repeated hypnotization of the subject is liable to be followed by more or less dangerous consequences. Inordinate emotionality, impairment

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[1] "Some Practical Considerations on the Nature and Induction of the Hypnotic State," the Medical Record of November 8, 1890.

of volition, and a tendency to become spontaneously hypnotized, or, at least, excessively drowsy, are some of the more obvious features of this post-hypnotic condition. I have at the present time under my care a gentleman who exhibits this neurosis—for neurosis it certainly is—in a striking manner. He is a man of rare gifts: he has maintained, and still enjoys, a high position in the community; and yet his mental decrepitude is so obvious that it is matter of astonishment to me that he has been able to disguise its source so long. Currently, he is regarded as a sufferer from mental overwork, and I must confess that I should have had great difficulty in arriving at the true nature of his difficulties had he not confessed that he had been hypnotized scores of times, and that his present infirmity had come on as the direct result of these abuses,—for abuses they certainly were.

Such a person as this is exposed to manifold dangers, for he has become so susceptible that not only is it possible for any one to hypnotize him, but he is able, without further assistance, to induce in himself the sleep-like state.

These, then, are the more manifest dangers of hypnotism.

Concerning possible Therapeutic Uses of Hypnotism.—I am not very sanguine as to the future

of hypnotism as a curative agent in nervous or other diseases. According to my own researches,—and those researches date back eight years or more,—the method is vastly more limited than one would imagine from the exaggerated claims which have been of late advanced in its behalf by over-zealous medical men. Let me mention a few of those limitations. In the first place, only a certain (unknown) percentage of persons are amenable to the hypnotic influence; or, to express it more exactly, only a limited number of persons are hypnotizable with the present means at our command. Secondly, the effects obtainable are evanescent; for, unless we hypnotize the patient so often as to incur the risk of doing him an injury, we cannot hope to perpetuate the suggestions sufficiently to do any good.

From these considerations it follows that the permanent effects which one may hope to produce upon the material economy through this class of psychical forces must be insignificant. Functions may, it is true, be exalted or depressed for the time being, but qualitative changes in the structures themselves are impossible. The internal capsule, the thalamus, the motor convolutions, the sensory tracts in the cord once destroyed are not to be restored by any form of interference. Moreover, a physiological substitution (in Bernheim's sense) for these and analogous

structures seems well beyond the farthest bounds of physiological probability. Hence, as I have previously mentioned, all attempts to apply hypnotism to the treatment of organic disease are opposed to sound thinking. Indeed, I regard such proposals as hurtful to science, and particularly medical science, inasmuch as the reputation of the profession for sound judgment is thereby greatly jeopardized. The facts which the advocates of such questionable methods have to present are still too few in number, and too meagrely substantiated, to form the basis of affirmative argument. What, then, is the position which hypnotism may be expected to assume in the neuro-therapy of the future? In my opinion, the *rôle* which it is destined to play is a subordinate one. In the light of its present and past history I do not see how it can be otherwise. As an adjunct in the management of minor degrees of hypochondria, morbid apprehension, depression, and hysteria, it may sometimes be invoked, but then only as a collateral expedient, and largely with a view to rendering the patient more tractable and amenable to other elements in the plan of treatment. The assistance afforded by an appeal to the expectancy of the sick is familiar to every physician. By invoking the aid of the hypnotic state such an appeal may be made with an energy which is not attainable while the

patient remains in the ordinary mental condition. But, while the miracles recorded by enthusiastic writers make, like Munchausen's tales, entertaining reading, they are not likely to enter into the sober realities of the consulting-room.

In view of what we now know of it, hypnotism is to be dealt with by the physician; for it is evident that a competent medical man is alone in a position to judge of its real or imaginary advantages. Certainly, only such a man should be allowed by our statutes to invoke its assistance in the treatment of diseases, however insignificant.

CHAPTER XIX.

CONCLUDING OBSERVATIONS ON THE PREVENTION OF RELAPSE—THE PROPHYLAXIS OF PAIN.

A VERY large proportion of pains exhibit a tendency to return. We must, therefore, do everything in our power to antagonize this baneful propensity, by interrupting the periodicity of the attack, and by continuing to employ such agents as experience has shown us to be useful in perpetuating the good already obtained. Some of the remedies previously mentioned, and, notably, quinine, iron, arsenic, aconitia, and cannabis indica, are very useful for this purpose. It is, indeed, necessary to do something more than to interrupt the paroxysm, though this of itself tends to permanent good by breaking up the painful habit; but, in addition, we must examine each case thoroughly, neglecting nothing in the history of the case which may possibly serve to enlighten us regarding the true origin of the pain. Sometimes we shall be able to trace the painful manifestations to some organic disorder; under these circumstances we may profitably invoke the

aid of general medicine. In other cases the pain is manifestly due to nerve-injury or some other accident, and we may then have recourse to surgery.

In by far the greater number of cases, however, we are able to trace the pain to neither injury nor organic disease; but, if we examine such cases attentively as to the state of the general health, we are usually able to discover some qualitative or quantitative change of nutrition of sufficient gravity to account for the phenomenon. It is, indeed, self-evident that where these derangements of nutrition exist such a complicated structure as the nervous system must inevitably deteriorate; and, as the whole history of neuritis shows, the peripheral nerves are especially liable to suffer. Sometimes the vitiated condition of the system is traceable to malarial poisoning; sometimes to syphilis; sometimes to gout; and sometimes, doubtless, to some form of autointoxication with which we are still unacquainted. Whatever the cause of the debility may chance to be, it should be removed as speedily as possible. Sometimes the pain disappears as soon as the general condition of the patient begins to improve; in other cases, supplementary measures—which have for their object the elimination of the propensity to return, so common to most forms of

pain—must be adopted. The latter phase of the subject has already been sufficiently discussed.

But not all debilitated persons are necessarily the victims of obstinate pain, as every physician is fully aware. Certain extraneous circumstances, certain phases of environment, are required, in order that malnutrition shall express itself in pain.

Among such external circumstances may be mentioned intense cold, with moisture, and sudden changes in temperature. These are the things which must be borne by those who, in the regular course of their daily vocations, are obliged to go from hot apartments into the cold, external atmosphere; or who are compelled to live in a climate of sudden changes, which really amounts to the same thing. Against circumstances of this kind it is, of course, impossible to provide an absolute remedy. We may counsel frequent changes of clothing to suit the fluctuations of temperature; we may advise that persons who go from hot to cold apartments, in the pursuit of their daily duties, shall make such transitions as gradually as possible; we may do this and more, and yet find that our injunctions are not of much avail, in so far as the attainment of permanent good is concerned.

Such being the unfortunate situation, one is often at a loss what to recommend. Sometimes I have

advised persons thus exposed to dress in thick woollen garments,—those next the skin being specially made with a view to facilitating the absorption of the cutaneous secretions; and over these conventional garments I have the patients wear a perforated vest of thick paper, lined with silk.

As a matter of course, great attention should be paid to all matters of diet. The patient should be put upon nutritious food, which at the same time must be digestible. Beefsteaks, mutton-chops, milk, cod-liver oil, and eggs are the staples where the anæmia is pronounced. Should the powers of assimilation be impaired, we must then resort to a good preparation of malt. I prefer that of Trommer, which acts upon starch with great energy, as every physician can ascertain by applying the iodine test. Pepsin and acids may, of course, be given when indicated. As a matter of course, red meats are to be avoided in rheumatic cases.

These, then, are the principles to be observed in the management of pain. As may well be imagined, the intricacy of the whole subject of pain is such, and its connection with a vast array of pathological conditions so intimate, that it is impossible to do more than formulate general rules for its management. Many cases will necessitate much tact in overcoming complicating circumstances of various

kinds. These I shall not attempt to discuss here, as they properly belong in the domain of general medicine or surgery.

If, however, I have succeeded in indicating principles of general utility, I shall be content. But if, in addition, I shall have been able to abate somewhat the use of enslaving drugs, I shall also feel that the ethical value of the work has been proportionately enhanced.

CHAPTER XX.

SUPPLEMENTARY OBSERVATIONS ON TORTURE, OR THE INFLICTION OF PAIN AS A JUDICIAL PUNISHMENT OR FOR THE PURPOSE OF EXTORTING A CONFESSION OF GUILT.

THERE is no chapter in the history of the human race so well calculated to cause a blush of shame as that which deals with torture.

That creatures with any discernible resemblance to men could have been found to conceive and execute such abominations; that society should have tolerated them; that the learned classes, or what passed for such, should not only have condoned the infamy, but actually invoked it, is an enigma before which even the astute psychologist stands aghast.

Whatever may be said of the corruption of civil and ecclesiastical government, which is such an apparent feature of the Dark Ages, this of itself is not sufficient to account for the systematized cruelty which found expression in the thumb-screw, the rack, and the fagot. The true cause of such moral obliquity is rather to be sought for in the unutterable ignorance, superstition, and moral debasement of the whole population, which alone made possible

the tyrannies of the feudal and ecclesiastical authorities throughout Europe. That the degradation of the common people was the real source of this organized brutality is shown by the fact that even in the republic of Switzerland, under a relatively liberal form of government, torture was a recognized element of ecclesiastical and judicial discipline. It was, moreover, precisely in such a soil as this that retributive ideas of justice, as opposed to the reformatory principles of modern criminology, were certain to flourish. As a result of this universal intellectual and moral debasement it was possible for both the civil and ecclesiastical powers to enforce their authority by incredible cruelty, and without fear of a popular uprising.

No revolutionary movement could, indeed, have succeeded, even had a portion of the population been disposed to throw off the yoke of despotism, since persons competent to lead such a movement were only to be found among the privileged classes, whose interests were bound up with existing institutions. The league of the civil authorities with the Church would, moreover, have rendered such an attempt abortive from the start, since the superstition of the peasantry rendered them abject slaves to the ecclesiastical power. In a word, it is only through the percolation of enlightened sentiment

among the masses of the people that one may hope to antagonize that fundamental predisposition to cruelty which is the birth-mark of animalism. The self-inflicted tortures of Oriental and European ascetics are but extreme manifestations of the belief in the retributive character of punishment. Even in our own day the great reforms in prison discipline, and the humane instincts which actuate the most enlightened persons, have not sufficed to eliminate from the minds of the ignorant the conception of revenge as an essential feature of judicial penalties. The conceptions which such persons entertain of the Deity are also colored by their brutish instincts; and, what is still more to be regretted, they have been able to foist their crude and barbarous conceptions upon persons who are infinitely their superiors in the scale of moral and intellectual enlightenment.

In 1640 occurred the last-recorded instance of judicial torture in England; but there is reason to believe that it was often secretly applied long afterwards. However this may be, it is certain that the revolting practice was in vogue both in France and Germany long subsequent to its official abolition in Great Britain. But even in the Irish dependencies of the latter country there was a sporadic revival of torture by the military judges in 1798.

As a means of extorting a confession it was commonly resorted to in various parts of Europe till the close of the last century. This seems incredible; but the fact is adequately attested.

It may readily be imagined that cries of protest were not lacking in the midst of this systematized barbarity; in fact, some of the most eminent men of the day were loud in their denunciations. Among those who gave vent to their disapproval were Beccaria and Voltaire; and to their endeavors the final disappearance of torture from Europe was largely due.

The following are some of the more common modes of inflicting torture, prevalent throughout the continental countries during the Dark Ages:

Pouring boiling oil or molten lead on various portions of the body by the aid of a perforated spoon or sieve. Flagellation with scourges of barbed iron, so that the flesh was extensively lacerated. Tearing the tongue out, a penalty for blasphemy. Stretching the victim on a species of couch and flaying him alive. Crushing the thumbs, toes, feet, hands, or shinbone by the aid of vice-like arrangements constructed with diabolical ingenuity. Suspected persons were made to submit in all European countries to the ordeal of the thumb-screw; and so fearful was the torture endured that the victim

frequently implicated himself and others by forced confessions of crimes of which all were entirely innocent. Breaking on the wheel, and burning to death,—the latter penalty being at one time exceedingly common in Europe. Among the chief victims were poor old women accused of witchcraft. Stretching the victim on the rack and pouring boiling oil or molten lead down his throat was also a common mode of judicial punishment.

These awful details of a nightmare of cruelty, which held all Europe in Satanic bondage for several centuries, are at once a warning against the dangers of primitive animalism, and an appeal to the spirituality and altruism which inevitably flow from the highest knowledge.

It should be a source of congratulation to all medical men to know that the physicians of the Middle Ages—or those who passed for such—usually did what they could to mitigate the sufferings of those of their unfortunate fellow-beings who were condemned to inquisitorial pain.

These, I believe, are the principal sources of the barbarity which pervaded all Europe during the Dark Ages,—a barbarity which found a most awful expression in tortures, the devilish ingenuity and cruelty of which seem incredible in the light of modern meliorism.

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THE END.

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