Recent surgical progress : a result chiefly of experimental research / by W.W. Keen.

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RECENT SURGICAL PROGRESS

A Result Chiefly of Experimental Research

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BY

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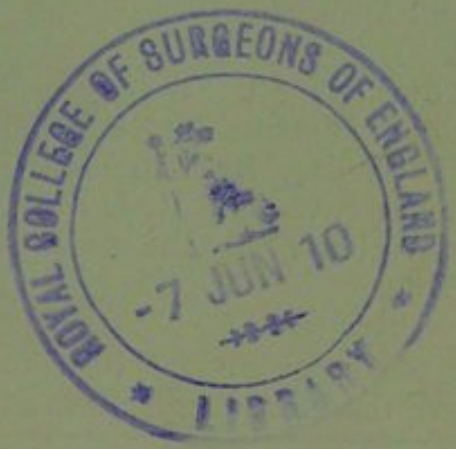

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RESEARCH DEFENCE SOCIETY.

Founded January, 1908, to make known the facts as to experiments on animals in this country; the immense importance to the welfare of mankind of such experiments; and the great saving of human and animal life already due to them.

The present membership of the Society (March, 1910) is more than 3,000. It is not an association of medical men or of men of science alone: its membership has been drawn from all departments of public life, and includes representatives of every class of educated Englishmen and Englishwomen, many of whom have taken an active part in the prevention of cruelty to animals. This fact is in itself a remarkable protest against

RECENT SURGICAL PROGRESS

In October, 1889, and June, 1893, in *Harper's Magazine* I gave some account of the progress of surgery. In the sixteen years that have elapsed since my last paper was written there has been much further progress in various directions. I can only consider a very few of these advances, and even those in a very incomplete manner.

SURGERY OF THE HEART.

Up to the publication of Fischer's paper in 1867, scarcely any surgeon took the surgery of the heart seriously. That paper was based on a study of 452 published cases of wounds of the human heart, and he showed that a patient might live for hours or even days with a wounded heart.

In 1881 Dr. John B. Roberts, of Philadelphia, made the bold proposal deliberately to sew up a wound of the heart, in spite of the fact that Billroth, the then most distinguished Continental surgeon, had declared that no one who wished to preserve the respect of his colleagues would ever attempt to operate on the heart. In 1896, after a number of experiments upon animals, two unsuccessful attempts to sew up a wound of the heart were published, followed happily in 1897

by Rehn's famous paper recording the first successful case. How quickly surgeons followed this happy lead is seen by the statistics given me by Dr. Francis T. Stewart (who himself has had a successful case), that up to June, 1908, 141 cases of wound of the heart had been operated on, and sixty-four of them had recovered. When one considers the difficulties of such an operation, —the speed with which the heart must be exposed by making a trap-door through the chest wall, and dividing two or three ribs, without, if possible, injuring the left lung by opening the sac in which the heart lies (the pericardium), clearing it of blood, seizing the heart, and while it is actively pulsating, with a jet of blood from the wound at every pulsation obscuring the field of operation—when one considers these difficulties, and yet notes that over 45 per cent. have recovered, and that this percentage of recoveries is steadily increasing, it is a matter of both surprise and gratification.

In a good many operations, when chloroform and even sometimes when ether is given, the patient suddenly passes into collapse, the heart ceases to beat, the respiration stops a few minutes afterward, and death quickly follows. Whether the pulsation of the heart could be re-established was first investigated by Schiff in 1874, and in animals, by means of rhythmical compression of the heart by the hand, he succeeded in starting the heart beating. It is impossible for me to state in detail the experiments of Pruss in 1889 and Battelli in 1900, both of whom were able in a considerable number of animals and by various methods to re-establish cardiac pulsation. The most extraordinary experiments, however, were made by Kuliabko in 1902 on hearts which had been removed from the body; all prior experiments having been made on hearts remaining in the body of the animal. Kuliabko showed

that after the heart had been removed from the animal and kept in ice for twenty-four or even forty-four hours, by filling the heart with certain fluids pulsation was re-established and continued for over three hours. He was able also to take the hearts from rabbits that had died a natural death instead of having been killed, and on even the second, third, and fourth day after death, by filling them with this fluid the isolated heart was started in its pulsation and continued to beat for several hours. He also tried the experiment in a number of instances in which the human heart was removed *post mortem*, even as long as thirty hours after death, and produced temporary pulsation. In a dog's heart which had been in snow for eighteen hours, and again after having been frozen in salt solution for twenty-four hours, Velich obtained slight contractions, but full pulsation was not reached.

Very naturally such experiments aroused the hope that some similar result might be reached in man. Attempts were made in desperate cases of sudden death, especially from chloroform. Ricketts has collected thirty-nine cases, of which twelve recovered! In other cases the circulation has been re-established for a number of hours, so that the surgeons were justified in expecting the recovery of the patients, but after a time the pulse and respiration failed, and recovery did not follow.

As can easily be seen, all this is so new, that it is impossible at present definitely to fix on the best method of reaching the heart, whether (as in cases of wounds of the heart) by making a trap-door over it in the wall of the chest, or by quickly opening the abdomen and reaching the heart through the diaphragm, or by other means which are too technical for me to describe. The report of the thirty-nine cases alluded

to gives a recovery rate of thirty-one per cent. That this will be increased in time there is no doubt.

The most recent researches in the surgery of the heart are experiments on animals to determine whether it is possible not only to expose the heart and operate on its exterior, but deliberately to open its cavities and operate on the valves. The results so far seem to show that it is no dream of a surgical Utopia, but that before long "valvular disease of the heart," hitherto an absolutely incurable disease, *may* be dealt with surgically and with the possibility of success. Happy the surgeon who, after suitable experiments upon animals have taught him exactly how to do it, may be able to cure such a hopeless malady!

But the happy history of progress is not yet all told. Three years ago I saw Dr. Crile of Cleveland chloroform a dog to death. By a suitable apparatus he was able accurately to record the very last pulsation of the heart and the last attempt at breathing. I stood by the dog, watch in hand, and when he had been dead—having neither pulsation of the heart nor breathing—for fifteen minutes, Dr. Crile injected toward the heart in the carotid artery a mixture of salt solution and adrenalin (the extract of a gland lying just above the kidney), compressed the dog's chest a few times, thus starting the heart and lungs going, and in less than three minutes the dog, though, of course, still unconscious from the anæsthetic, was just as much alive as he had been a half-hour before. Partial but not permanent recovery has been obtained by Dr. Crile in animals even twenty-five minutes after actual death. If further experience confirms these results, we may have a better method of resuscitation than exposing the heart as above related.

Without the experiments which had been made upon

animals and proved the efficacy of the adrenalin, which was added to the salt solution, no one would have thought that the extract of a gland lying above the kidney would be of the least value in saving either animal or human life. We know now, as a result of such experiments, and with positive certainty the effect of the adrenalin and its immense value in these cases as well as in others.

SURGERY OF THE ARTERIES AND VEINS.

From the heart naturally we pass to the arteries, which conduct the blood from the heart to all parts of the body. Wounds of the arteries by gunshot, by stabs, by accidents, etc., are not at all uncommon. Until very lately when a large artery or a large vein was wounded our only remedy was to cut down upon the blood vessel and tie it above and below the wound. If it were an artery leading to the arm, and still more if it were one leading to the leg, as the principal supply of blood was cut off, gangrene was a very common result.

In case of aneurysm, a disease in which the walls of the artery become weakened at a certain point, bulge, and finally rupture, producing death, till recently, as in the case of a wounded artery, our only resource was to expose the artery and tie it. Here again, for the same reason, the chief danger was gangrene. In the treatment of aneurysm, Matas of New Orleans has made the greatest improvement since the days of John Hunter, over a century ago. Instead of tying the artery above the aneurysm and arresting the current of blood in the artery, he opens the sac (that is, the dilated portion of the artery or aneurysm), and, if I may so describe it, sews the wall of the sac together on the inside, leaving, however, a small tunnel through which the circulation is continued.

Up to June, 1908, eighty-five operations of this kind have been done, with seventy-eight recoveries. This method of operating obviates almost entirely the danger of gangrene. Thus far apparently European surgeons have neglected it, only two operations having been done in Italy and four in Spain, while the remaining seventy-nine have been done in America.

But it is in cases of wounds of arteries and veins that perhaps the most remarkable progress has been made, and the story shows how wide-spread are the benefits derived from a single discovery—how to sew together the two ends of an artery which has been cut across. When a blood vessel was wounded we were obliged to tie the artery or vein to prevent the patient from bleeding to death. As I have explained, this cutting off of the blood supply often produced gangrene. In 1894 Dr. Robert Abbe, of New York, made a number of remarkable experiments upon animals; among them two are especially noteworthy. Opening the abdomen of a cat, he cut across the aorta (the great blood vessel passing directly from the heart to the lower limbs) and inserted a thin sterile glass tube, tying the aorta over flanges made at the two ends. After four months the cat was shown at the New York Academy of Medicine, "fat and strong, with the glass tube still in his aorta." Again, he almost amputated a dog's foreleg, leaving the limb attached to the body by nothing but the artery and vein. He then wired the two ends of the bone together, sewed muscle to muscle, nerve to nerve, etc., and after dressing the limb, encased it in plaster. After four months this almost amputated limb was perfectly united, and Dr. Abbe drew the inference that a completely amputated limb might be successfully grafted. How fruitful these experiments were in practice we shall see later.

When an artery is partially divided or completely cut across, naturally the proper course would be in the former case to sew up the wound, or in the latter to sew the two ends of the blood vessel together, and so re-establish the circulation. To describe all of the technical difficulties of such an operation would be impossible in a brief paper. They have been investigated experimentally by Murphy of Chicago, Payr of Graz, Crile of Cleveland, Carrel of New York, Guthrie of St. Louis, and others.

The great difficulty has been to find a suitable method of sewing the two ends of a completely divided artery together in such a way that the *blood will not form a clot* at the necessarily somewhat rough and irregular line of union and *totally obstruct* the vessel just as if it had been tied. At last, within the past few years, especially by the labours of Carrel, Guthrie, and Crile, a suitable method has been devised by which now any surgeon, who will familiarize himself with the process and obtain skill in its application by a few experiments upon animals, can operate in such cases with confidence. This method has not only found its chief application when the blood vessels have been completely divided, but has made possible another very remarkable achievement; namely, direct transfusion of blood.

The older method of transfusion was to connect the artery of a healthy person with the vein of the patient by means of a rubber tube. The great danger here, as in the case of wounds of the artery, was that the blood would clot. If this clot passed into the vein, whether of arm or leg, it went upward till it finally reached the heart, and was then driven into the lungs, where it would act like a cork and block up a larger or smaller artery of the lung, cutting off the circulation in that part and producing a dangerous and in most cases fatal

pneumonia. So great was this danger and so frequent the disaster following indirect transfusion by this means that for a number of years it has been practically abandoned. Instead, therefore, of transfusing blood itself, surgeons have for some years relied upon supplying the loss in volume of the blood by means of salt solution, and this in very many cases has answered very well. As a result, however, of these recent experiments on the suture (sewing) of blood vessels end to end, we now are in a position to pass the blood from the artery of a healthy person into a vein of the patient without any danger of its clotting, provided the operation is properly done. This has had a very striking climax in certain cases in which there has been severe loss of blood. Let me give but one very briefly—the case of the baby of a well-known young medical man. Immediately after the birth of this baby there set in severe hemorrhages from the mouth, nose, stomach, and bowels, the so-called "hemorrhage of the new-born." The various remedies which were tried all failed, and on the fourth day the baby was dying. I am sure that every woman, especially, will sympathize with the grief of these parents over the impending death of their first-born. In the middle of the night the father called Dr. Carrel of the Rockefeller Institute to his assistance, lay down alongside of his baby, an artery in the father's arm was laid bare and sewed end to end to a vein in the baby's leg, and the blood was allowed to flow from father to child. The result was most dramatic. A few moments after the blood began to flow into the baby's veins its white, transparent skin assumed the ruddy glow of health. The hemorrhage from every part of the body ceased instantly and never returned, and, as the published account[1] so vividly puts it, there was no period

[1] *Medical Record*, May 30, 1908.

of convalescence—immediately before the operation the baby was dying; immediately after the operation it was well and strong and feeding with avidity. That baby to-day is a strong healthy child.

The same method of direct transfusion has been used by Crile, Downes of New York, and others, in a still different way. Many patients come to surgeons so weak, either from loss of blood or from the dreadful effects of cancer, tumours, and other diseases, that to operate upon them with the coincident shock and loss of blood is almost sure to be fatal. In such cases very frequently prudent surgeons, to their great grief, are obliged to say "no," and allow the patient to die rather than attempt an operation.

In a child two years and two months old Downes found a tumour of the kidney which filled the entire left half of the abdomen, and in whom the quality of the blood (the hemoglobin) was reduced to forty-five per cent. of the normal, the child's face was drawn, the pulse rapid and feeble, and the appetite very poor. Operation was delayed for a few days in order to see whether good care and good food would not cause improvement. On the contrary, the child was no better, and there was a measurable increase in the size of the tumour, so rapidly was it growing. On September 11th the father's artery and the child's vein were united and the blood allowed to pass from father to child for forty minutes. Every five minutes the quality of the blood of the child was tested by taking a few drops of it, and it was found that at the end of forty minutes the quality of the blood had risen from forty-five per cent. to eighty per cent. The pulse was full and strong, and the child's colour and general condition showed equal improvement. On the following day the tumour, weighing a pound and two ounces, together with the

left kidney, was removed, and the patient was discharged perfectly well on October 18th, having already gained three pounds in weight.

Crile has even, if possible, in a more striking way demonstrated the use of this method in eleven successful cases in human beings. Instead of effecting the transfusion a day or two before the operation, he has placed the patient and her husband alongside of each other at the time of the operation, connected the husband's artery with the wife's vein, and as soon as, from the inflowing blood, her condition has improved sufficiently to withstand the etherization, the shock, and the loss of blood, has proceeded with the operation. During the operation the loss of blood by the patient has more than made up by her gain from her husband's blood, and she has been enabled to withstand the shock incident to the ether as well as the operation; and at the end of the operation she has been in better condition than before it was begun. As Crile has declared, "in some cases the results seem nothing short of a resurrection from the dead."

Recently a nephew of Bishop Lawrence of Massachusetts was thus rescued by direct transfusion of blood. To quote the Bishop's exact words, "The boy was at death's door, and is now in perfect health."

TRANSPLANTATION OF PARTS OF THE BODY.

Our ability successfully to sew severed blood vessels together has borne still further fruit. It has enabled us to transplant whole organs—for example, one or, in other cases, both kidneys, or an entire leg from one animal to another. These possibilities, however, have only been realized step by step, not only by devising success-

ful methods of sewing the ends of large vessels together, but by discovering that nature can supply a transplanted part spontaneously with small blood vessels and thus enable it to retain its vitality.

Everybody, for instance, knows about "skin-grafting." Reverdin of Geneva first snipped off little pieces of skin from the arm or leg and deposited these pieces on the surface of an ulcer, protecting them by suitable dressings from being displaced. He found that these little pieces when placed on the ulcer adhered to it, that they lived, that small blood vessels nourished them, and around each little island of transplanted skin the ulcer began to scar over (cicatrize), and finally healed. This emboldened Krause of Berlin to take much larger pieces of skin, so that at present after removing a tumour, if we cannot bring the margins of the skin together, we cut from the thigh of the patient long strips of thin skin an inch wide and several inches long by means of a sharp razor and transfer them to the raw spot. As a rule, they adhere, preserve their vitality, are nourished by new small blood vessels, and in a short time we can thus "skin-graft" a large raw surface and have it heal. The thigh quickly heals.

But this kind of "grafting" is not limited to the skin. Many years ago Ollier of Lyons showed that by taking from the bone of a living animal a bit of the membrane which covers all bones (the periosteum), he could transplant it to another place on the same animal, or even into another animal, and the periosteum would produce new bone. Following that discovery, which was the result of laborious experiments, we constantly now make what are called "subperiosteal" removals—for example, of a part or the whole of a lower jaw, preserving the periosteum, and from it a new more or less perfect bone is developed.

Recently Lexer of Königsberg has gone much farther. In the case of a man who had a stiff knee-joint bent at an angle and immovably fixed by firm bony union, he removed the bones forming the knee-joint and took from an amputated leg the healthy knee-joint and put it in place of the bone that he had removed from the stiff knee. The transplanted bones both above and below united firmly with the bones of the patient, and the strange knee-joint from the amputated leg served a perfectly normal function. In another case he removed the upper end of the shin bone, taking away, therefore, the lower *half* of the knee-joint (a much more difficult and dangerous operation, as it opened the knee-joint), and replaced this with a similar portion of bone from an amputated leg with entire success.

The last achievement that I have seen of this ingenious surgeon was reported to the German Surgical Congress in April, 1908. Most of my readers are familiar with the fact that when a patient, through disease or accident, has lost his nose a new one can be made for him. This is a very ancient operation. The new nose is usually made by cutting a flap from the forehead, leaving it attached by a footstalk between the eyebrows. This flap is then twisted on its footstalk and sewed in place. But it has serious disadvantages, Sometimes the twist in the footstalk is too tight; this compresses the blood vessels, and the flap becomes gangrenous. In that case not only has the patient lost his nose, but he is left with a face disfigured by a great scar in the middle of his forehead. Even if the attempt to give him a new nose is a success, the scar on the forehead always tells the story, and, moreover, the new nose, having no bone, is flabby and unsightly. Lexer records a case which is not only surprising, but one

may say also amusing. Having a patient requiring a new nose, and having amputated a leg for some disease which did not involve the thigh bone, he took a bit of the lower end of this thigh bone, whittled it into the shape of a nose, and bored out two nostrils in it. He then made an incision in the skin of the forearm of the patient, loosened the skin to some extent from the underlying muscles. placed the new bony nose under the skin, and closed the wound. After three months, when the skin of the forearm had become firmly attached to the bony nose, which was only a temporary tenant of his forearm, the skin and the new bony nose were cut out in one piece and transplanted to the face. This gave the patient a good, firm, bony nose, which at the same time was covered with the healthy skin of the forearm, and avoided any disfiguring scar on the forehead.

Even more surprising things have been done by Carrel and Guthrie in the transplantation of soft parts which had been preserved by various means, and yet grew fast and fulfilled their function. For example, in November, 1906, Carrel removed from the neck of a dog a portion of the carotid artery, and put it into cold storage, where it was kept at an even temperature of 32° to 33° F. After twenty days in cold storage he transplanted this into the aorta of a cat, and after two years and one month the cat was perfectly well. Again, in May, 1907, a portion of a dog's aorta was removed, and a similar portion of the artery behind the knee removed from the amputated leg of a man was put in its place, and eighteen months later the dog was still in thoroughly good condition.

Guthrie also reports that he removed from a dog a portion of the great vein alongside the aorta (the vena

cava), preserved it by formalin (a chemical preservative) for sixty days, then removed a corresponding portion of the carotid artery from the neck of another dog and replaced it by this portion of vena cava, and the animal was living and well when the report was made three weeks later.

Still more extraordinary experiments have been done by Carrel and Guthrie in the transplantation of entire legs or of entire organs. Carrel amputated the thighs of two dogs, A and B, and united the thigh from dog A to the stump of the thigh of dog B, wired the ends of the bones together, sewed artery to artery and vein to vein, etc. (it will be seen now how essential is this discovery of a successful method of sewing the arteries end to end), and applied a suitable dressing and a plaster cast. The new leg grew fast, and when I personally saw it there was firm union.

This experiment, which has also been done by Guthrie, is only a further step, it will be observed, beyond the operation of Abbe in 1894, when he amputated the entire leg with the exception of the blood vessels, which he dared not cut, for with the imperfect knowledge we possessed fifteen years ago he could not possibly have successfully sewed them together.

Quite as noteworthy also are some experiments of Carrel and Guthrie in which they have taken the two kidneys with their blood vessels and the corresponding part of the aorta and the vena cava, the two ureters, and the part of the bladder into which the ureters entered, from one cat, and transplanted them into another cat from which the same parts had been removed. I saw this operation done a few months ago in an hour and a half. An hour after the operation the cat was in very much better shape than most of my patients are an hour after I am through with them.

She recovered perfectly, and the transplanted kidneys worked as well in the second cat as they had done in the body of the original one.

CANCER.

The surgical record of cancer consists of a happy achievement and a temporary failure. The achievement is the practically permanent cure of forty to fifty per cent. (and some surgeons have had even a larger percentage) of the cases operated upon: that is to say, patients who have had cancerous tumours removed have lived for five, ten, fifteen, and even twenty years without any recurrence. This has been gained by the most painstaking study of the modes of extension of the disease and by more thorough and earlier extirpation. I presume even now, with our imperfect knowledge of cancer, if every patient who found a lump in any part of the body would seek the best available surgeon, it would be within the bounds of truth were I to say that, taken at this early stage, the cures would probably amount to sixty-five or even seventy-five per cent. of the cases operated on. But what all surgeons are seeking is (1) the cause and (2) the means of cure of cancer *without operation*—a professional altruism which I never cease to admire.

That cancer is mildly contagious is shown by the undoubted existence of the so-called "cancer houses" in which, for want of proper disinfection, repeated cases of cancer have arisen. Moreover, animal experimentation and a few cases in human beings have shown that if the cancer cells of the tumour come in contact with a fresh raw surface during operation, the disease may easily be spread in this way. Hence every modern surgeon is

extremely careful to protect the raw surfaces of the wound from touching, even momentarily, the cancerous tissues or being moistened with their dangerous juices. For the same reason our operative methods, too, have been changed, so that now we take out the entire mass of infected glands as well as the original tumour in a single piece, and never put a knife into any of the cancerous tissue. If we are obliged to do so, this knife is cast aside and a new one substituted.

The cancer problem is being attacked vigorously in cancer laboratories in Buffalo, Boston, London, Heidelberg, and elsewhere with extraordinary zeal. Many men are devoting their lives wholly to the study of this one great and perplexing problem. It is being attacked on the clinical side to see if we can learn anything by such experience; by the microscopists to find if the minute study of the tissues will reveal the cause; by the bacteriologists to see if they can discover any germ which may originate the tumour; and finally by animal experimentation to study the life history of such tumours from start to finish by inoculating animals with the cancerous tissue and tracing the effect of the inoculation, destroying one animal at the end of a few days, another in two or three weeks, another in months, and so on; and in a multitude of other ways too technical to relate, in order to obtain the most intimate and exact knowledge possible. But so far the cause of cancer has eluded us.

I have called this a temporary failure because I look forward with confidence to the future. At any moment I am expecting to learn that some pathologist will really discover the cause of cancer (for many have cried, Lo here! or, Lo there! only to find they were in error), and thus confer a boon on the human race second only to the discovery of the bacillus of tuberculosis.

Let us now turn to another subject, in which, once more, the question of transplantation of organs will come up for consideration.

GOITRE.

This disease is well known, of course, to all who have travelled in Switzerland and Savoy, where such an immense number of cases occur. That it is not very uncommon in America is shown by the fact that the Mayo brothers have done over 1,000 operations for goitre. In my paper in October, 1889, I referred to what was an amazing report in that year by Kocher of Berne of 250 operations for goitre, with a mortality of but 2·4 per cent. The last statistics which have been published by Kocher cover 3,000 operations for goitre, with the marvellously low mortality of only three deaths in each 1,000 cases!

When we began to operate on goitres, the whole of the thyroid gland (the enlargement of which produces the goitre) was removed. It was soon found, however, that in a certain percentage of cases the patients underwent a dreadful change; namely, they looked as though they were bloated; their hands and features became thickened and enlarged; their intellects became dulled, so that some of them even passed into the state of cretinism. Others, on the other hand, became greatly excited, and died with what is known as tetany, a disease which derives its name from its resemblance in many respects to tetanus or lockjaw. In order to obviate these dangers the first change that was made was to leave a portion of the gland behind. If this was done, the patient was not attacked by the general change (myxœdema or cretinism), though fatal tetany still sometimes followed.

In 1880 Sandström discovered in the human subject some small glands about the size of grains of wheat, situated behind the thyroid gland, but in immediate connection with it, and therefore called the parathyroid gland. Human beings and many animals usually have four, sometimes three, and sometimes only two. Moreover, their situation varies very much, and at first it was impossible to recognise them at operation. What their function was, and what would be the effect of their removal, nobody knew. Accordingly, experiments were begun upon the lower animals by removing some or all of these glands in order to discover their function. It was quickly learned that when they were *all* removed, the animals died from tetany, just as human beings occasionally did after operations for goitre. Then it was suspected that the cause of the human tetany was not the removal of the thyroid gland itself, but of these little parathyroids, and that the good effect of leaving a part of the thyroid gland was due not only to leaving the thyroid itself, but to accidentally leaving at least one of these little glands. Numerous experiments upon animals, as well as the terrible experiments which we were ignorantly making upon human beings, from whom many surgeons, *without knowing it*, had removed these parathyroid glands, have shown that, small as they are, they are essential to life, and that if they are all removed, the withdrawal of the secretion they furnish to the body always causes death.

At the German Surgical Congress in April, 1908, Kocher reported that he had transplanted these glands for certain reasons into the upper end of the shin bone just below the knee. This he did first in animals, and found that when, at a later operation, he removed the whole of the thyroid gland and the parathyroids from the neck, the animals did not suffer from tetany. He

has now gone a step farther, as his animal experimentation justified him in doing, and has done a similar transplantation in the human subject. The results of this operation have not yet been published, but I judge from his report to the Surgical Congress that it was favourable. If so, a new means of security is provided for us in operations for goitre.

There is another form of goitre, however, which is much more fatal than the ordinary goitre with which most people are familiar. It is called exophthalmic goitre, or Graves' disease, the latter after Graves of Dublin, the former because the eyes protrude very markedly. Along with these two symptoms there is a very fast pulse, running up to 160 or 200. The disease very frequently destroys life. It has been operated on by a number of surgeons with a good degree of success, but recently an antidote has been prepared by Rogers and Beebe of New York which seems to promise much in the way of cure and may possibly obviate operation. One of the gentlemen most interested in the development of this antidote was spurred on in his experiments by the fact that his own wife was suffering dreadfully from the disease and rapidly nearing the grave. The idea of preparing this anti-serum or antidote had come to him while watching the action of another anti-serum, the whole effect of which was spent upon the kidney, no other organ of the body being affected. This suggested to him the idea that an anti-serum might be prepared from diseased thyroids which would have its sole effect upon the thyroid gland. Soon after this fruitful idea had developed in his mind, a patient with Graves' disease died, and at the *post mortem* he obtained the thyroid gland from this unfortunate patient. With this a number of rabbits were inoculated, but in consequence of his total ignorance of the proper method

of using it, all but one of these rabbits died. From this one rabbit there was prepared an extraordinarily good serum which absolutely cured three human beings and partially cured two others. The second of the three who were cured was the wife of the doctor himself. Her attending physician, one of great eminence, had declared to her husband that how long she would live was only a question of hours. By reason of the fact that its instant use was imperative before it could be thoroughly tested on animals so as to learn its dangers and how to avoid them, he nearly killed his own wife in the attempt to cure her; but she is to-day a perfectly well woman, thanks to the experiments upon this small number of rabbits.

Reckoned in rabbits, what is the value of your wife, your husband, or your child?

All of this animal surgery I mention for two reasons: first, because with minor exceptions the methods and the results of animal surgery and of human surgery are *identical;* and therefore, secondly, because it is a necessary preliminary and precautionary step to similar surgery in human beings. All of the recent surgery in animals above described will surely be applied, with suitable modifications, to man within a short time, immensely adding to his comfort and saving his life, with all which that implies for himself and his family.

This paper is a record of only a few of the wonderful achievements of modern surgery in human beings which have resulted chiefly from experiments on the lower animals. That clinical investigation—that is, investigation by observation at the bedside—has been of value, no one doubts; but had we been *restricted* to clinical observation only, not a tithe of the progress recorded would have been made. I scarcely know anything

more touching than the story told me by Dr. Carrel of a boy who wrote to him, offering himself for experiments of any kind, if by so doing he could obtain a pension for his mother. Not long since I also received a similar letter from a doctor who was afflicted with a disease which he knew was mortal. He wrote me saying that he was willing to submit to *any* operation, however painful, *without any anæsthetic*, if it could be of any use to humanity.

Moreover, this progress is not only in surgery, but in medicine; and doctors have been in the forefront in sacrificing their lives, sometimes by accident, sometimes voluntarily, in order to achieve these splendid results. Doctors have died by diphtheria, by plague, by infection of various kinds, have slept in the clothes and in the beds of yellow-fever patients in order to discover whether the fever was spread by these means, and have offered up even their lives in order to prove that yellow fever was caused solely by the mosquito, and thus clinch the proof that was needed in order that this dreadful scourge might be eliminated; a scourge which has cost a holocaust of lives and millions of dollars even in the United States alone.

As a result of the sacrifice of these five human lives Cuba has been freed from yellow fever for the first time in nearly two centuries, and in the Canal Zone not a case of yellow fever has occurred for over four years. Colonel Gorgas is the one man who has made the building of the Panama Canal a possibility. No lower animal being subject to yellow fever, experiments could not be tried upon them, and hence Lazear and others lost their lives. In the fine words on Lazear's tablet in the Johns Hopkins Hospital, written by President Eliot: "With more than the courage and devotion of the soldier he risked and lost his life to show how a fearful pesti-

lence is communicated and how its ravages may be prevented."

I am old enough perhaps to relate without reproach the following personal incident. While writing this paper a friend gave me the *Journal of Zoophily* for January, 1909. On page 2 I found in an editorial note on a large gift by its founder to the Rockefeller Institute the following: "But the gift only fanned into fury the opposition of women to experiments on living animals, *no matter how great the anticipated benefit.*" Three days later, between noon and bedtime, I happened to meet four former patients, all of whom thanked me warmly for having saved their lives. Three of these four patients owed their lives chiefly to the knowledge derived from experiments upon animals. No further comment need be made on those cruel words—"no matter how great the anticipated benefit." With a thrill of delight I fervently thanked God for what modern surgery could do.

By their fruits ye shall know them. Look at the following startling contrast—a table, the first part of which could easily be more than doubled:

WHAT THE FRIENDS OF EXPERIMENTAL RESEARCH HAVE DONE.

(1) They have discovered antiseptic surgery, and so made possible the wonderful results of modern surgery. To complete his beneficent work, Lord Lister was compelled to go to France by reason of the stringency of the English anti-vivisection laws.

(2) They have made possible practically all modern abdominal surgery, including operations on the stomach, intestines, liver, gall bladder, pancreas, spleen, kidneys, etc.

(3) They have made possible all the modern surgery of the brain.

(4) They have demonstrated how lockjaw spreads from the wound; how sometimes it can be arrested and cured; and, still better, how it can be prevented, so that practically tetanus has been banished from surgical operations.

(5) They have reduced the death-rate in compound fractures from sixty-five per cent. to less than one per cent.

(6) They have reduced the mortality of ovariotomy from two out of three to two or three out of one hundred.

(7) They have abolished yellow fever.

(8) They have made possible the cure of nearly all cases of hydrophobia.

(9) They have cut down the mortality of diphtheria in New York City alone from 158 deaths per 100,000 in 1894 to 38 per 100,000 in 1905, and practically the same story is told all over the world.

(10) By the use of the serum recently discovered by Flexner at the Rockefeller Institute they have changed the mortality in cerebro-spinal meningitis from seventy-five per cent. and even ninety per cent. to thirty per cent. or less.

(11) They have shown the cause of acute tetany after operation for goitre, so that it now can be prevented.

(12) They have almost completely abolished the dangers of maternity, reducing its death-rate from ten or more mothers out of every hundred to less than one in every hundred.

(13) They have shown the cause and the method of propagation and of prevention of the deadly malaria which devastates whole regions and armies. Its extinction is only a matter of time.

(14) They have reduced the mortality of tuberculosis by from thirty to fifty per cent., for Koch's discovery of the tubercle bacillus by animal experimentation is the foundation stone of all modern progress in the treatment of tuberculosis.

(15) They have enormously benefited animals by discovering the causes and the dangers of tuberculosis, Texas fever, anthrax, glanders, hog cholera, and other infectious diseases of animals, thus enabling us to combat them more successfully or even to prevent them.

WHAT THE FOES OF EXPERIMENTAL RESEARCH HAVE DONE.

Nothing but to stand in the way of progress. Not a single human life has been saved by their efforts; not a single household made happy. Not a single disease has had its ravages abated or abolished.

The victims of their sincere but misguided zeal are men, women, and little children. Even the lower animals may well cry, Save us from our friends.

R. CLAY AND SONS, LTD., BREAD ST. HILL, E.C., AND BUNGAY, SUFFOLK.

the attacks which have been made against the researches that the Society has been formed to defend.

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