EXPERIMENTAL SURGERY

Including Surgical Physiology

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FIFTH EDITION

BALTIMORE
THE WILLIAMS & WILKINS COMPANY
1964

First Edition, October, 1937
Reprinted, February, 1942

Second Edition, April, 1949

Third Edition, February, 1954
Reprinted, February, 1957

Fourth Edition, 1959

Fifth Edition, 1964

Library of Congress
Catalog Card Number
64–11099

COMPOSED AND PRINTED AT THE
WAVERLY PRESS, INC.
MOUNT ROYAL & GUILFORD AVES.
BALTIMORE 2, MD., U. S. A.

FOREWORD

To write a foreword to the fifth edition of *Experimental Surgery* is a privilege which I welcome. The twenty-six years that the book has been in existence have seen a remarkable increase in interest and activity in experimental surgery, in its scope and in refinement of its technics. There have been parallel advances in veterinary surgery. In both these developments this book has played no small part.

The senior author, in his early years, was associated with that great pioneer of experimental surgery, F. C. Mann of the Mayo Clinic. Following that he became a professor of physiology, but during World War II volunteered for service in the Royal Army Medical Corps, served in Malaya and suffered arduous experiences as a prisoner of the Japanese. Now, as a practicing physician he retains his interest in physiology, a field in which his personal contributions are well known.

The title of this book is *Experimental Surgery*, but it could equally well be designated "Applied Surgical Physiology." To produce such a volume there could be no happier association of authors than Professor Markowitz and his colleagues of the staff of the Ontario Veterinary College. The members of this team have not only great practical experience in animal surgery—the depth of their knowledge of the basic sciences and their skill as teachers is evident throughout the volume.

Horizontal integration in the teaching of the basic sciences and vertical integration to relate these to clinical subjects is now a recognized principle in medical education. This principle is well exemplified in *Experimental Surgery*. It is much more than a text book of surgical technics. The students or research workers who read the book, and even more, those who are fortunate enough to be able to carry out the described exercises, will find themselves absorbing anatomy, physiology, pathological chemistry and pathology without being aware of the indistinct boundaries between these disciplines. That is as it should be.

FREDERICK G. KERGIN, F.R.C.S.

PREFACE

This edition has again been extensively revised. We keep a large box handy into which we throw such scraps of information, references, and reprints, as might be useful for our next edition. From this we select what we need, attempting to stick to principles and omitting procedures that involve complicated gadgets (such as those for vascular anastomosis, for example). Several workers have written us pointing out errors and to these we are thankful. It is possible that we have slighted an occasional worker by overlooking his writings: to him we state that if he *sends us reprints*, we will be less likely to be remiss.

Books, like people, mature. A comparison between the first edition (1937) and this one brings out some striking differences, chiefly in the literary style (the new part being less discursive and more compressed) and in the general tone, which is far less polemical. This is because the teaching of surgery has greatly changed for the better, although the *Zeitgeist* seems to have deteriorated:

> Eheu fugaces, Postume, Postume,
> Labuntur anni, nec pietas moram
> etc., etc.

In the spirit of the times, and as a criticism of them, we would render this bit of Horace thus:

> As I lie on my bed
> Crying over the years
> And my fears
> Tears
> Run into my ears....

And again, a line from Horace, who had his tongue in his cheek:

> Non sum qualis eram, bonae sub regno, Cynarae ...
> (I'm not the guy I was, when you were my queen, Baby ...)

(It has often seemed to us that English prosody does not use the Alexandrine as freely as it might).

This book over the years has accumulated a considerable following. It has even been said that it has contributed to the great increase in surgical experimentation. We may therefore, freely confess its chief shortcoming: that, to use an outmoded cliché, it is neither fish, flesh nor fowl. However, experimental surgery as a science in its own right is related to clinical surgery only in that the tools we use are the same. What, for example, is the effect of shunting the bile *via* the common bile duct into the portal vein? The problem here is at the outset technical--the avoidance of thrombosis. In this respect it is *surgery*. Once solved, the problem from then on might be anything: pathological, physiological, or biochemical. There are many such problems in experimental surgery, and the science is growing. The fruit of such labors is bound to be useful to the clinical surgeon.

In closing, we wish again to express our gratitude to our publishers who, without being stuffy, have been thorough-going gentlemen in their dealings with us.

THE AUTHORS

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I /

INTRODUCTORY REMARKS

Suave, mari magno turbantibus aequora ventis,
E terra magnum alterius spectare laborem.
Lucretius, *De Rerum Natura*

We have often heard graduate students of surgery, in attendance at good schools of their art, bemoan the fact that so little opportunity is given them to learn the craft of surgery. It is not the best course in surgery to insist on postgraduate training in pathology, physiology, biochemistry and anatomy and then to let the student hold a retractor for his final year of the course, and do a few standard operations. This is to insist on a proper training in everything but surgery. It is beside the point to defend this policy on the grounds that surgery is founded on the fundamental sciences, for every medical student is well grounded in these, and to demand a post-graduate knowledge of them at the expense of surgical craftmanship is to neglect emphasis where it is much needed. It must be obvious that the combined presence at an operation, of the professors of anatomy, physiology, pathology and clinical diagnosis would not help a licensed physician operate for a ruptured appendix or a toxic goiter. There is no need to belabor this point: Oscar Wilde has stated that even that which is true can sometimes be proven.

While it has some title to the dubious distinction of being original, this book makes no claim to being exhaustive. Much of the technic described is that in use at the Institute of Experimental Medicine of the Mayo Foundation, where the senior author spent three happy and busy years. Much comes from the Johns Hopkins Hospital group, and from the Chicago groups. Much of it is our own, of which some is heretofore unpublished. The remainder is, or soon will be, more or less standard procedure in the broad field of experimental medicine.

This book, nevertheless, is in no sense a compendium, and in general we deemed it wiser to confine ourselves chiefly to such procedures as we have frequently performed. It was Plato who said that knowledge is eloquence, and a textbook should strive to be eloquent in an age when good teaching and good teachers yield first place to research workers. It is unfortunate that the word *text* (Latin) is not related etymologically to the word *teach* (Anglo-Saxon), for surely a textbook should contain only things that are interestingly taught. For a dull lesson is no lesson, and as long as in so doing, he manages to convey soundly the principles of his science, a good teacher is justified in preferring as teaching material such subject matter as he knows best. Only in so doing can he inject enough of his personality to make his course interesting, alive and memorable.

A lecture is the procedure whereby the notes of the lecturer are transferred to the notebook of the student, generally without passing through the mind of either. It is, however, the criterion of a *good* lesson that the student remembers it without effort; and we ourselves shall remember, as long as we

remember anything, some of the teaching we have had from N. S. Shenstone, the late J. A. Oille, Duncan Graham, E. Stanley Ryerson, the late E. P. Cathcart, the late Roscoe Graham, the late J. J. R. Macleod, the late "Tiny" Campbell, D. V. M., and F. W. Schofield, to mention a few. We think it was Milton who stated that a good poem must be "simple, sensuous, and passionate," and these are also the qualities of a good lesson. It must be *simple* because human beings are disinclined to exert themselves sufficiently to grasp complicated relationships, and anyway, complicated explanations and relationships always turn out to be untrue. Complicated researches, like complicated clinical arguments, always are found out to be mistaken. A good lesson must be *sensuous*, that is, it must be displayed so as to appeal to our sense of beauty; and few—none—of the branches of science fail to strike the student as exquisitely beautiful when appropriately presented. A good lesson like a good sermon must be *passionate*, i.e. full of feeling, i.e. vehement and eloquent; a good teacher is tired at the end of an hour's lecture, for if it is done well, the work is exhausting.

There is a great pleasure in learning a science, not because of the power and glory it gives us, but because knowledge is a heightening of consciousness, and it is therefore just as instinctively desirable as is undesirable the reverse state of unconsciousness and death. In this regard, experimental surgery is a typical science.

The world (parenthetically speaking) has a mistaken notion about the nature of science and scientists. Our greatest scientists have been children of clergymen, and the truly scientific fervor, as Einstein has pointed out, is akin to religious ecstasy. Every good textbook of science says, in effect, Come unto me all ye that labour and are heavy laden and I will give you rest.

"Come unto me all ye that labour. Ye
Whose souls are heavy laden, come to me,
And I will lead you forth by streams that heal,
And feed you with the truth that sets men free."
Mallock, "*Lucretius, On Life and Death*"

. . . arva, beata
Petamus arva divites et insulas. . . .
Horace, *Epod. xvi*

Scientists often seem to be matter-of-fact people, unromantic and even hard headed; that is because the scientific attitude is realistic, as opposed to ritualistic. But there is a vague, continuously satisfying glow of emotion about any science, and he who has accepted and learned its discipline is marked for life. For example, there is a richness to the culture of biology that compares in vividness to the most intense affectations that artistic people have about their environment.

Consider the following paragraph, from Macaulay's famous essay on Milton:

"The Puritans were men whose minds had derived a peculiar character from the daily contemplation of superior beings and eternal interests. Not content with acknowledging, in general terms, an overruling Providence, they habitually ascribed every event to the will of the Great Being, for whose power nothing was too vast, for whose inspection nothing was too minute. To know him, to serve him, to enjoy him, was with them the great end of existence. They rejected with contempt the ceremonious homage which other sects substituted for the pure worship of the soul. Instead of catching occasional glimpses of the Deity through an obscuring veil, they aspired to gaze full on his intolerable brightness, and to commune with him face to face. Hence originated their contempt for terrestrial distinctions. The difference between the greatest and the meanest of mankind seemed to vanish, when compared with the boundless interval which separated the whole race from him on whom their own eyes were constantly fixed. They recognized no title to superiority but his favour; and, confident of that favour, they despised all the accomplishments and all the dignities of the world. If they were unacquainted with the works of philosophers and poets, they were deeply read in the oracles of God. If their names were not found in the registers of heralds, they were recorded in the Book of Life. If their steps were not accompanied by a splendid train of menials, legions of ministering angels had charge over them. Their palaces were houses not made with hands; their diadems, crowns of glory which should never fade away. On the rich and the eloquent, on nobles and priests, they looked down with contempt; for they esteemed themselves rich in a more precious treasure, and eloquent in a more sublime language, nobles by the right of an earlier creation, and priests by the imposition of a mightier hand. The very meanest of them was a being to whose fate a mysterious and terrible importance belonged, on whose slightest action

the spirits of light and darkness looked with anxious interest. . . . Thus the Puritan was made up of two different men, the one all self-abasement, penitence, gratitude, passion; the other proud, calm, inflexible, sagacious."

When this description of the Puritans is appropriately subdued and modernized, it characterizes thousands of English-speaking scientists. This may seem incredible, but only to those who have not worked with them.

Needham in one of his delightful and scholarly essays mentions that while the apparatus and subjects of each science are different, the architecture of the scientific method conforms to a definite style. It is a platitude that in the face of a great truth, arguments cease. The logic of each science is always the same: the truth is capable of verification by anyone who has ears to hear and eyes to see withal, and it will bear weight—i.e. it is substantial, i.e. we can trust it and can build upon it, i.e. in the last analysis, it is useful. These are, after all, frail criteria, and philosophers keep telling us that this is sheer pragmatism; that we are building upon sand. This cannot be so, for this mighty edifice that has been erected proves (to continue the biblical metaphor) that the foundations must be of rock. It is almost ridiculous to consider this thing: that which we call a scientific truth depends only (1) upon a practically unanimous jury vote, and (2) it must be useful in predicting and harmonizing other accepted truths, or in performing such miracles as wireless transmission. John Stuart Mill, one of the few sensible philosophers, enunciated the above as the criteria of truth. They are intuitively hailed by all scientific workers.

To a fish, the whole world is water; to a round-worm, *Ascaris suilla*, the world is encompassed (to use Shakespearean language) by the guts of a hog. To an anatomist, surgery is skilled, prescient dissection; to a common enough and capable enough type of surgeon, it is a craft taught him by his preceptors; to a physiologist, it is applied physiology. It appears, hence, that in regarding a few phases of surgery from a physiological background, we are not acting illogically; we hope that it will prove a meritorious point of vantage.

Only a small part of the art of surgery can be taught in the lecture room. Experience, repetition and practice under a variety of circumstances are essential. Operating on dogs is of great assistance along this road. The student who has mastered the difficult phases of experimental surgery on animals may better profit by his experience in the human operating room. He will certainly be less apprehensive about its purely mechanical aspects. To be sure, even an expert in experimental surgery must learn human operative surgery. The reverse is quite as true for the surgeon who would work successfully in the experimental operating room. However, the purely technical aspects have so much in common that it is merely a case of adapting what one has learned in the animal to the treatment of diseased conditions encountered in the hospital operating room. Occasionally a procedure used in clinical surgery, such as blood vessel anastomosis, can be mastered only in the experimental laboratory.

The operative technic described in these pages is suitable for animals, usually dogs. However, it does not follow that it is equally and always suited to human beings. We refuse to allow the student the pretense that what he is doing is operating on a patient for the cure of an ailment. The procedures we describe are the best we know to achieve the desired end, and we have found it inadvisable to make concessions to the needs of the human operating room, where such concessions result in an inferior technic for work on dogs. This, in an occasional instance, may give the impression that dog surgery is crude; or, in another experiment, that it is too delicate, judged by clinical standards. It is neither; it is merely necessary to achieve safely the end desired. Nowhere in the procedures described in this book is safety sacrificed to speed and elegance.

Constant, diligent practice is absolutely essential to good surgical technic. A surgeon performing an operation 100 times a year will do it better than another who performs it but ten. Some people, as the late C. H Mayo has said, may make the same mistake 100 times and call it experience, but in general the rule holds that practice and experience make for perfection in surgery.

Surgery of the dog, in so far as it resembles human surgery, is in this instance of great value in training surgeons for the operating room. One who has seen able young men struggle through a cholecystectomy on a dog, can appreciate the full value of practice. The same young man may be doing Eck fistulas and colectomies 2 months later with a verve and assurance that is the despair of his newly arrived colleagues. The visceral organism preparation often amazes experienced surgeons, but the dissection required is no more delicate than dissecting out the glands of the neck, and the practice gained in one facilitates the acquisition of the technic of the other.

Many of the advances in medical science during the past century have been due to the realization that a sound knowledge of pathology is essential to the trained internist or surgeon. Today, it is appreciated that to know disease we must understand the normal functioning of tissue, as well as its normal histology. It has indeed become incumbent upon us to attempt the diagnosis of disease before structural changes have occurred in tissues, and to treat disease with an intelligent concept of the physiological factors underlying the deviation from health. However, while this viewpoint is acceptable in most instances, very little inquiry will reveal that clinicians are unequally endowed with the necessary physiological knowledge. Physicians are sometimes found who are unacquainted with rudimentary facts demanded of intelligent medical students. For example, not all clinicians could write a creditable account of the factors governing the variations in heart rate during exercise, fever, or arterial or venous distention. Yet the physiological facts bearing on such phases of the heart's action are well known (constituting what might be called a branch of gilt-edged physiology). Unless the clinician is aware of Bainbridge's reflex, he is ignorant of the intrinsic nature of the tachycardia of congestive heart disease. Should he fail to comprehend the factors affecting the motility of the colon he will not understand the modern methods of treating Hirschsprung's disease.

A surgeon will generally state that the cause of death in peritonitis is toxemia. Such a bald statement is like the answer of Molière's candidate for a medical degree who asserted that opium puts people to sleep because it has soporific virtues. Failure of the circulation in acute infectious disease does not have the same mechanism as that of hemorrhage or traumatic shock. For example, plasma volume is not decreased, and transfusions do not save life. It is not caused by venous pooling because filling the venous system does not improve the circulation. As a matter of fact, the entire cardiovascular system appears to be damaged by the infection. There is injury to the heart, as well as loss of venous tone, and the only way to improve the circulation is to bring the infection under control. Treatment should therefore be directed toward overcoming the infection, rather than toward treating the circulatory failure itself.

It may be seen from Chapter X that the experimental surgeon has contributed materially to what we know about peptic ulcer, having shown that the withdrawal of alkaline duodenal secretion in such a way that the intestinal mucosa is exposed to gastric chyme for abnormally long periods, leads to the formation of an ulcer in a high percentage of experiments, regardless of the surgical procedure employed (Mann and Williamson). In the human being only one fact has been clearly demonstrated about duodenal ulcer, namely, that the average gastric acidity of patients with duodenal ulcer is greater than that of normal persons. Kearney and associates studied the hydrogen ion concentration of the duodenal contents of normal persons with varying degrees of gastric acidity, and compared them with findings in patients with duodenal ulcer. They found that the pH values were lower and remained there for longer periods in patients with duodenal ulcer than in normal persons. Thus the duodenal mucosa of patients with duodenal ulcer was bathed in a more highly acid fluid for longer periods of time than in normal patients. They felt that this was due to larger quantities of acid gastric juice entering the duodenum; to a relative, if not an absolute deficiency of neutralizing and diluting fluid; and to a disturbance of neutralizing and diluting mechanism, as indicated by a delayed ap-

pearance of bile-colored duodenal content, following the entrance of gastric content into the duodenum. The student of surgery who familiarizes himself with the technic of duodenal drainage soon accustoms himself to thinking in these terms. It is quite as reasonable to demand this knowledge of him as it is to require that he be able to recognize the commoner pathological lesions at autopsy or operation. A technical knowledge of physiology should not be regarded as analogous to such purely mechanical acts as the fixing, cutting and staining of microscopic sections. For example, when a student has successfully perfused the heart by means of Starling's heart-lung preparation, he has acquainted himself with a number of important facts relevant to modern heart surgery which no amount of pedagogy can supply. No amount of didactic instruction can impart to the student the essential truth that many obvious physiological phenomena are the basis of common diseased states. Our experience at the Mayo Clinic, at the Veterinary Clinic, and in a busy private practice has convinced us that such an attitude is acquired by the student familiarizing himself with certain physiological procedures, such as those described in this book.

It is hoped that this book will convey to the reader the great value of experiments on dogs in the solution of practical surgical problems. Can a loop of intestine be reversed without producing intestinal obstruction? How much intestine can be resected without serious inanition resulting? What is the best type of permanent jejunostomy? What tissues, if any, lend themselves for the reconstruction of the common bile duct? What is the best technic for transplantation of ureters? Is an interrupted or continuous suture line preferable in closing a surgical incision? Is a minimal amount of suture material advantageous or can one use a lock stitch beneficially? Can one produce peptic ulcer by creating in dogs certain conditions that have a bearing on the etiology of this affliction in patients? What is the effect on blood flow through the hind limb of severing the lumbar sympathetic trunk? Is cholecystogastrostomy a harmless procedure to adopt in patients who are not the victims of incurable malignancies or obstructions of the biliary outlet? Is fascia a better suture material than catgut or silk under certain conditions? How can you revive a dead heart? These are but a few of the surgical problems that have been solved by experiments on dogs, and their results have often become incorporated into the modern practice of operative surgery.

A satisfactory technic for ligating a major artery like the abdominal aorta affords a concrete example of a surgical problem requiring solution. Total ligation of the aorta as a clinical procedure is rare, and in practice is nearly always fatal. This is largely owing to the fact that the occluding ligature cuts through the aorta with resulting fatal hemorrhage, but it is also due to the inadequacy of the circulation below the ligature. This is a procedure of which the technic is best successfully developed on large dogs. At first sight one might predict that the occlusion of a large artery is a relatively simple problem surgically. However, in spite of some distinguished effort in this direction, the problem is not yet solved. All methods which depend on external compression are dangerous. Pearse has used a cellophane sheath, but not always successfully, there having occurred a rupture of the aorta in some cases. Occlusion by rubber bands in multiple stages has been suggested by Owings. Matas reported a brilliant cure of an abdominal aortic aneurysm using cotton crepe as ligature material. However, Morton and Scott had a fatal outcome following this technic.

Our knowledge of arthritis has already begun to profit immensely by intelligent recourse to the methods of experimental surgery. This field requires not the casual investigator but one who would devote at least a decade to the creation of a groundwork of knowledge regarding the physiology of joints. So little work has been done in this field that textbooks on physiology contain no reference to it. Leriche found that the injection of an anesthetic into the cavity of a painful joint did not alter the sensation of pain. Is it true that sensory nerve endings are absent from the synovial membrane, and present in the deeper capsule remote from the joint? Is it true that local sym-

pathectomy relieves joint pain? Is articular surface sensitive when tested with a needle point? What factors regulate the mucin content of synovial fluid? Is it true that the cell count in articular cartilage is inversely related to the age of the animal? How many are aware that the respiratory power of cartilage diminishes grossly with age? Ham has pointed out that young cartilage cells do not possess phosphatase, while older hypertrophied cells do, which explains differences in their ability to calcify. Joints are readily made experimentally. Unfortunately, joints are all too easily obliterated by ankylosis. This should continue to be profitable study for those interested in orthopedic surgery (*vide* J. A. Key, Bauer, and others).

A synthetic sponge which acts as a framework for living tissue would serve many useful purposes in surgery. Grindlay and Waugh found such a sponge in one of the plastics. Polyvinyl sponge is a lightweight, wettable, resilient material which resembles sea sponge. It is made from polyvinyl alcohol and formaldehyde by a commercial process and is available in pure form. It may be sterilized by boiling in water and while hot is easily molded into various shapes. It is cut into thin slices by first filling its interstices with gelatin solution, and then placing it in a refrigerator overnight.

Polyvinyl sponge was implanted surgically, either subcutaneously, intrapleurally or adjacent to breast, ear cartilage, periosteum or muscle in 37 experiments involving 28 dogs. Pathological studies of sponge and adjacent tissue were made in 24 experiments at intervals up to 18 months.

Inflammatory reaction or evidence of deterioration of sponge has not been observed. The spaces within the sponge rapidly became occupied by non-inflammatory fibrous tissue.

Results obtained on lower animals are directly applicable to human beings since there is no difference between the functioning of human tissues and that of animals. Perhaps there is a difference in uric acid metabolism between man and the dog. On the other hand, a patient with acute yellow atrophy of the liver presents a picture very similar to that of a dehepatized dog. Pancreatic diabetes in the dog (of the Sandmeyer type) is similar to human diabetes. Tetany after parathyroidectomy in dogs is similar to the human type. The realization that results obtained in animals apply to human beings is largely responsible for the practical advances in endocrine therapy of recent years. There is no reason to suppose the similarity stops short with the glands of internal secretion. It seems likely that the phenomena of life and the adjustments to disease are very similar, if not identical, all through the class *mammalia*.

To be experimentally minded is exceedingly valuable to the clinician since, better than anything else, it teaches him to weigh clinical evidence. Moreover, the advance of the science of medicine depends largely upon appropriate experiments in the laboratory. Anyone who has seen the convulsions of recently fed dehepatized dogs, or of meat-fed Eck fistula dogs, soon wonders if the convulsions of eclampsia are not of similar nature. The solution of this problem depends upon the duplication of its major features in animals. Whether this is achieved by a deliberate series of experiments or by chance observation remains to be seen.

Old ideas die hard. The ascites of portal cirrhosis has long been explained on the basis of back pressure in the portal vein. However, this is only partly true, since ligation of the portal vein does not cause ascites.

Grindlay has shown that in cirrhosis of the liver due to CCl_4 there is a great increase in lymph flow from the liver. In ascites produced by obstruction of the inferior vena cava in the thorax, the liver lymphatics are greatly dilated. To cause ascites there must be obstruction of the hepatic venous outflow. It is surgically treated by decompressing this outflow by an Eck fistula.

There is an unfortunate current belief that physiology is a deep, abstruse subject requiring a profound knowledge of physics, chemistry and mathematics for its understanding. Ultimately, physiology may become an account of biological reactions in terms of physics and chemistry. However, today physiology is in much the same elementary state as the chemistry of Lavoisier's time. It is yet in the condition in which Claude Bernard found it, and in most in-

stances is quite unprepared for physicochemical exposition. In short, we are largely ignorant of the basic anatomical and biological phases of physiology by which in a crude sort of way we attempt to correlate form with function.

In addition to Bernardian physiology may be mentioned that branch of physiology so ably extended by Jacques Loeb, known as "general physiology," a branch of the science which attempts to interpret cellular reactions in terms of physics, chemistry and mathematics. Tremendous impetus was given to this type of study by the demonstration of parthenogenetic fertilization of the ovum by purely chemical means. Although many physiological studies include both the means of Jacques Loeb and Claude Bernard, it is obvious that the basic ground work in accord with the methods of the great Frenchman must first be prepared before one can talk of fundamental physicochemical changes going on in cells and in colloidal micellae.

The story of insulin illustrates this. In 1869 Langerhans described peculiar masses of tissue in the pancreas distinct from the acini. Minkowski and von Mering next discovered the anti-diabetic function of the pancreas. These and Hédon proved that this function must be dependent upon an internal secretion. Then Banting and Best (with Collip and Macleod) discovered insulin, which Abel, and later Scott, crystallized. How insulin works is not known. Hepburn and Latchford, in experiments on perfused hearts, established that it accelerates the consumption of glucose by muscle and Best, Dale, Hoet and Marks showed that insulin was essential for any considerable synthesis of muscle glycogen from glucose. Many workers have shown that phosphate is involved in the action of insulin. Cori has shown that insulin catalyzes the hexokinase system, which pituitary extract inhibits. Insulin affects the metabolism of fat cells.

When one stops to realize that we are comparatively well informed concerning insulin, the full significance of the Bernardian attitude toward physiology will be appreciated. It is apparent that the chief present need of physiology is for such simple experiments as Claude Bernard designed, which are based on ordinary common sense and require but little equipment. To this phase of physiology, the experimental surgeon has much to contribute.

Meliora sequi: This book aspires: we believe that the jack-of-all-trades in our profession, the general surgeon, human or veterinary, will find it useful; so will that drawer of water, the urologist, and that hewer of wood, the orthopedist; so indeed will all workers in experimental biology—all, that is, except those incredible soothsayers of today, the Freudian psychoanalysts. These gentry may not read the stars, but they interpret dreams. True, they do not concentrate upon the entrails of chickens, but they have more than a passing interest in the last inch of the human digestive tube. If you wish to know what to do until the psychiatrist arrives, you won't find it in this book.

REFERENCES

GRINDLAY, J. H., AND MANN, F. C.: Surgical uses of polythene: An experimental study. Arch. Surg., 1948, 56, 794–812.

GRINDLAY, J. H., AND WAUGH, J. M.: Plastic sponge which acts as a framework for living tissue. Arch. Surg., 1951, 63, 288–297.

MORTON, J. J., AND SCOTT, W. J.: Ligation of the abdominal aorta for aneurysm complicated by rupture into retroperitoneal space. Ann. Surg., 1944, 119, 457–469.

OWINGS, J. C., AND HEWITT, J. F.: Successful experimental ligation and division of the thoracic aorta. Ann. Surg., 1942, 115, 596–608.

II /

THE ANTIVIVISECTION MOVEMENT

IN THE CHILDREN'S HOSPITAL

Emmie

Our doctor had called in another: I never had seen him before,
But he sent a chill to my heart when I saw him come in at the door,
Fresh from the surgery-schools of France and of other lands—
Harsh red hair, big voice, big chest, big merciless hands!
Wonderful cures he had done, oh yes, but they said too of him
He was happier using the knife than in trying to save the limb;
And that I can well believe, for he looked so coarse and so red,
I could think he was one of those who would break their jests on the dead,
And mangle the living dog that had loved him and fawned at his knee—
Drenched with the hellish oorali—that ever such things should be!

Lord Tennyson (*Circa* 1860)

Be kind to your web-footed friends,
For a duck may be somebody's mother.

Tune: Sousa March,

It is one of the failings of a democracy that those who are most articulate often manage to control legislation. They get laws passed which are not in the best interests of society; and as a consequence, a well organized and well disciplined minority, especially if enthused with a religious or an obsessive fervor, may become a constant nuisance. Good citizens must be eternally vigilant of such people and their propaganda must be exposed and counter-claims exerted lest unwise laws be passed that will be difficult to repeal. Nowhere has this been better illustrated than in the constant activity of a group of persons who have banded themselves together to oppose the use of living animals for experimental purposes.

It may be assumed that intelligent people in English-speaking countries regret the need of such experiments, but sanction them because of the real benefits that have resulted and are constantly accruing. For example, in the state of California, the opponents of animal experimentation felt sufficiently sure of their position to force a referendum in 1922 to abolish vivisection, with the following results: for abolition, 226,339; against abolition, 574,783. In the same year in Colorado a similar referendum to abolish vivisection was defeated by five to one: for abolition, 33,416; against abolition, 178,120.

In the District of Columbia, every 2 years for half a century, a bill has been introduced in Congress to prevent animal experimentation; more recently, the bill has limited itself to exempting the dog, because it was felt first that public sentiment is strongest on behalf of this animal, and next that this would be "the thin edge of the wedge," and

that once the dog had been exempted it would be easier to abolish all animal experimentation. It is sad to think that by means of a professional legislative secretary a bill that the great majority of people do not want can be repeatedly introduced in the House and must be soberly given a hearing that costs thousands of dollars and requires constant vigilance and the expenditure of much time and energy on the part of those of our profession who appear to testify.

In 1946, the following bill was introduced by Congressmen Lemke. It hence became the duty of a United States Congressional Committee on the District of Columbia to have a formal hearing.

(H. R. 5572, 79th Cong., 2d sess.)

A BILL To prohibit experiments upon living dogs in the District of Columbia providing a penalty for violation thereof

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That from and after the passage of this Act it shall be a misdemeanor for any person to experiment or operate in any manner whatsoever upon any living dog, for any purpose, except operations normally performed for the convenience of the owner and the welfare or curing of said dog, in the District of Columbia.

SEC. 2. That any person convicted of a violation of this Act shall be sentenced to pay a fine of not less than $100 nor more than $500, or to undergo imprisonment for a term of not less than three months nor more than one year, or both such fine and imprisonment.

SEC. 3. That all Acts or parts of Acts inconsistent herewith are hereby repealed.

Those in favor of a similar bill in 1930, testified as follows:

Mr. T. W. Pond, of the Animal Protection Bureau of Baltimore, Md.: "That animal experiments are of no value in discovering remedies for the treatment of human sickness, and that hence they constitute unnecessary cruelty.

"That the nature of pellagra has not been elucidated by experiments on dogs, contrary to the claims of Goldberger.

"That sunstroke is the result of acidosis, and can be prevented and cured by sweetened water; hence there is no need to do such experiments as those of W. H. Hall and E. G. Wakefield, 1927, J. A. M. A., July, who reported "A Study of Experimental Heat Stroke."

"Of all the doctors I have interviewed at least 50 per cent say that in their particular practice they can find no benefits derived from the vivisection of animals."

Dr. W. H. Hay, a licensed medical practitioner, "who perhaps has the largest practice in Buffalo, N. Y.": "Nearly 90 per cent of the registered physicians of the United States are not interested, either directly or indirectly in vivisection. . . . The results of that vivisection to date have not given the human race anything that could not have been secured much better in other ways."

"Insulin, to be sure, has given us means of combating the rapid cases of diabetes in the young. In the old we are learning not to use it. Too many deaths occur from its use. . . . There is no evidence to support the belief that insulin has in any way lengthened the life of the diabetic."

"We have added to the ordinary diabetic death rate, which we have no evidence has been postponed in any case, the increasing total of incidental deaths from an overdose of insulin. . . ."

"There is no doubt that a standard could be found out on the dog, but even if we found that out, the dog's toleration of too much glycogen in the blood or too little glycogen in the blood may be entirely different than human toleration. . . ." (This is but one example of the learned doctor's profound erudition. Glycogen in the blood! Shades of Claude Bernard!)

"I contend that every experiment that the human imagination could conceive has been already performed on the dog and we have nothing more to learn and that what we have learned is of very negligible import to the human."

Mrs. C. P. Farrell, President, Vivisection Investigation League of New York; Secretary, International Conference for the Investigation of Vivisection: "We have presented to the House District Committee petitions containing hundreds of thousands of names of citizens who are asking for the passage of this bill. We are told by many members of the House District Committee that they have received more letters in favor of this measure than any other bill."

"I have been in daily touch with the movement for 22 years. The large society, the Vivisection Investigation League, of which I have the honor of being president, was organized in 1911. In 1912 the International Conference for the Investigation of Vivisection, an organization of humane societies, was organized. When we had our bill of 1916 it consisted of 13 societies. Three years ago, there were 47 societies which were members. Today this conference, which, by the way, is re-

sponsible for this bill, is composed of 131 societies. New anti-vivisection societies are constantly being formed, four since the beginning of the year. At its meeting last month, the conference elected to membership six new societies. And this movement is extending throughout the world."

"In Great Britain they have been using animals for years and years, and they admit every year when they make their report—the Royal Society—they haven't learned a thing. They go right on experimenting."

". . . When they take a normal healthy child and inject syphilis into it, that is not for the benefit of this child."

Rev. Dr. C. Ernest Smith, D.D., President, International Conference for the Investigation of Vivisection: "As a matter of fact, experiments on dogs have been going on for years and years, and medical men generally have come to the conclusion that there is nothing valuable obtained from these experiments, and now they have taken up human vivisection. That is going on now, and that is a confession of failure on the part of the dog to give any evidence."

"I am president of an organization in New York that has 131 branches scattered from the East to the West."

". . . We have made no advance in medicine in the last 50 years. If anything, we have retrograded. Why, sir, you can't cure a common cold. You haven't cured cancer. What in the world are you doing with all these experiments you talk about, pellagra and all that sort of thing?"

Miss M. E. Orgelman, Legislative Secretary, Vivisection Investigation League: ". . . Do you happen to know that vaccination, that everybody has more or less sworn by for centuries, was given up last month by Germany?" . . . "Italy has on April 26, 1930, abolished all animal experimentation except in cases of extreme necessity."

It now became the turn of our profession to state why they opposed the bill. They narrated the usual recital of facts which make obvious that modern medical science owes its very existence to intelligent experiments on animals. Vivisection was amply vindicated by a number of outstanding surgeons, physicians and scientists, ably marshalled together by Dr. G. W. McCoy. The testimony of the late Dr. M. C. Hall, the distinguished zoologist and veterinarian, was especially inspiring. It should be read by all who are called upon to defend our cause.

Dr. M. C. Hall, Bureau of Animal Industry: ". . . The proponents of this bill will not understand nor long remember the evidence I have presented here to show that much of benefit to dogs and man has come from my work, and they will tell you next year and through the following years that nothing of the sort has happened. They are that sort of persons.

"They will ignore the fact that I speak authoritatively as a trained zoologist, veterinarian, and experimenter when I say that dogs are in many ways similar to man, and that the findings from experiments have benefited dogs, and that they can be and have been transferred to the field of human medicine to the great good of humanity.

"When they enter the field of science, these persons enter as unskilled labor, devoid of such training and information in science as would qualify them even as laboratory helpers, yet they set their prejudiced and uninformed statements against the statements of the scientists who speak from the years of training implied by their academic and professional degrees and from their years of experience in the field of science."

". . . Some of the supporters of the antivivisection movement—and I put Mrs. Farrell in this group—are normal persons who honestly desire to save animals and persons alike from suffering. Others exist of whom I have heard raise the suspicion that they are sadists whose exaggerated consideration of animals compensates for a streak of cruelty toward human beings; you may recall instances of criminals who were extremely fond of some pet animal, and recall that more than one person has been shot by a dog's owner to avenge some slight to his dog. Other supporters of the movement are animated by an obsessive antagonism towards science, research, and experimenters, and this animosity is the dominant motive, much more intense than their fondness for dogs or their desire to prevent suffering. . . . In this latter group I place Miss Orgelman. . . ."

". . . Now, if the proposition were put to almost any ordinary person devoid of obsessive ideas: Do you prefer the suffering or death of 100 dogs to the suffering or death of a million dogs? The normal person would say without hesitation "yes." The suffering or death of a million dogs is ten thousand times as serious as the suffering of 100 dogs, just as much as 1,000,000 dollars or votes is ten thousand times as much as 100 dollars or votes. A Congressman would not need to be told that even once, let alone twice. But the exceptional person does not reason that way. He or she takes the position that the suffering or death of the million dogs is a dispensation of a wise and unscrupulous Providence, whereas the suffering or death of the 100 dogs is the dastardly work of a fiendish scientist. This idea is thrown in the scales with the 100

dogs, and the million dogs are out-weighed; let them suffer."

Col. E. V. Vedder, Director of the Army Medical School, Washington, D. C.: ". . . A clergyman testified yesterday that the use of animals for our benefit was morally indefensible. Yet he wears clothes made from the hair of animals, shoes made from their skins, and we presume that he eats meat. His parishioners wear furs taken from animals caught in traps and permitted to starve to death in torture. To be logical, therefore, he should be clothed in paper and have renounced the use of meat, eggs, and milk which is only obtained by killing the calf, or must admit that the use of animals for our own benefit is morally defensible. . . ."

It must be apparent from the above extracts of an actual hearing before a senate committee that ordinary antivivisectionists are immune to the usual methods of exposition by reasoned argument. They strain at a dog and swallow a baby. They are the stuff that martyrs are made of. They are an unfortunate evil in our midst, and we must accustom ourselves to their presence as we do to bad weather and to disease. As long as scientific investigation is the disinterested thing that financially it is, we shall have them with us. There must be many people opposed, for instance, to the use of automobiles, who might wish to unite to bring about legislation to banish motor cars from our streets; but their position at the outset is hopeless, for they could not possibly succeed against an industry with billions of dollars at stake. Antivivisectionists do not concern themselves with the gelding and spaying of farm animals; it is no easy thing again to cope successfully against an industry worth millions, and besides the common sense of the world would ridicule their efforts to death. However, scientific experiments have no vested interests, and the laity do not know what we are achieving. Our only defense is constant vigilance, while at the same time, we attempt to educate the public as to what benefits have resulted from such experiments. Let us try to make the time not far distant when the justification for such research will be as obvious as that for the slaughtering of farm animals for food, and the incarceration of criminals. Meanwhile the American Physiological Society has set up a permanent standing committee on the use and care of animals, and the National Society for Medical Research publishes a bimonthly bulletin designed to overcome antivivisection obstructionism by promoting public understanding of the methods and requirements of experimentation on animals.

In attempting to educate the public it should be borne in mind, that what is obvious requires no proof, and that an interesting narration of the facts is the greatest eloquence. If public utterances are planned (and this is usually unwise), they should be made by a delegated spokesman who is suited for this kind of work.

"Every man is not a proper Champion for Truth. . . . Many have too rashly charged the Troops of Error, and remain as Trophies unto the enemies of Truth. A man may be in as just possession of Truth as of a City, and yet be forced to surrender; 'tis therefore far better to enjoy her with peace than to hazard her on a battle" (*Religio Medici*, Sir Thomas Browne).

There are two forces more powerful by far than the humanities and sciences: they are ignorance and folly. Animal experimentation should hence be done only under the auspices of educational or scientific groups. To neglect this precaution is to invite trouble, no matter how important the experiments. It is essential never to purchase dogs from strangers for laboratory purposes lest someone's pet be among them. The best procedure is to purchase mongrels from a reputable dealer who makes a business of supplying laboratories with animals. It is necessary to investigate the character of the firm first to be sure that the animals are legally procured. In smaller cities if many dogs are required, it may be necessary to purchase in lots of twenty or more from such a dealer in a nearby district. This practically eliminates the remote possibility that someone's pet in the neighborhood has inadvertently found its way into the laboratory. Often when a person loses his dog, he will call at the laboratory to inspect the supply of animals. It is reassuring to inform him that his dog could not possibly be in the supply since all the dogs were procured at some distance from the laboratory. If this fails to satisfy, an accurate description of the animal should be written down before the kennels are in-