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Addresses on Surgical Subjects

Geo. Andrew

1st Bart ^ 1865-193

By
SIR BERKELEY MOYNIHAN, Bart.
President of the Royal College of Surgeons
of England

Philadelphia and London
W. B. SAUNDERS COMPANY
1928

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To

Dorothy

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and

Pat.

PREFACE

These addresses and essays first appeared in the "Lancet," "The British Medical Journal," the "Practitioner," and "Surgery, Gynæcology, and Obstetrics." I am indebted to the Editors of these Journals for permission to publish them.

There is something more, I hope, in these papers than a transient interest. They embody the faith of one who has spent his life in Surgery, a faith which unwaveringly holds that there is no finer craft, nor any more sacred mission than the practice of our Art. They seek to shew that even supreme excellence in our Art is not enough; that Surgery is also the most powerful weapon of research ever placed in the hands of man for his own welfare. The Art of Surgery made perfect is the handmaid of its Science.

In expounding my gospel I may be found more than once to have repeated a part of my message. Since the addresses were given before different audiences, on occasions and in places far apart, repetition, in order to enforce my teaching or to afford an illustration, could not well have been avoided.

Berkeley Moynihan.

John Hunter's birthday,
1928.

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ADDRESSES ON SURGICAL SUBJECTS

HUNTER'S IDEALS AND LISTER'S PRACTICE*

On this day, the 199th anniversary of his birth, we commemorate the services of John Hunter to the Science and the Art of Surgery. In this year we celebrate the centenary of the birth of Lister. Hunter and Lister! From all who have ever served the cause of surgery these two stand apart by reason of the immeasurable gifts which they have conferred upon their fellow men. May we now recall something of Hunter's work and of his ideals in respect of the conquest of disease which the genius of Lister made possible?

Man's life is warfare. The individual, the whole race, is beset by foes, unresting, relentless. Against them our defence, if we are ever to subdue them, must be carefully planned and diligently strengthened. But defence, however stubborn, is not enough. Attacks designed after scientific study of the enemy strongholds and methods, and launched with impassioned zeal, must never for one instant falter. Not all our attacks meet with success. We are cheered when we gain some notable victory; yet when we suffer defeat, as wave after wave of our advance is checked and repulsed, we do not lose heart. Failure inspires us to fresh and still more eager endeavour.

In this year, the centenary of Lister, we rejoice to acclaim the greatest victory ever won by man against his enemies. We, who are in active work to-day, are perhaps unable to measure the full extent of that victory; for during the long fight, lasting almost exactly sixty years, our standards have been so changed that we cannot truthfully compare our work with that of our intellectual ancestors. Operations from time immemorial so mortal as to be prohibitive are now freely performed without anxiety. Operations formerly unimaginable are now matters of everyday occurrence. The mere tale of such work done does not adequately illustrate the change. On my last day as surgeon, on the full staff of my hospital, I performed six abdominal operations. Not one of these was practised by any member of our staff during the year in which I became house surgeon, nor had such a diagnosis as was made in three of these cases, and verified at the time of operation, ever then been attempted in the history of medicine. Above all, a statement of facts and a comparison of methods does not in adequate degree convey to our minds the difference of outlook of the intellectual and spiritual approach of a man to his daily task, as between the surgeon in the days before Lister and since. It is barely possible for us to imagine how men felt about their daily work when an eminent surgeon could speak of his hospital as a "house of death"; when hospitals "were little short of pest houses," as Lister said[1]; and when the oppressive mortality compelled the closure of wards or of a whole hospital for months, until the curse was lifted from them.

Before and After Lister

The change, of incalculable benefit to humanity, is due to one man, Lister.[2] Before Lister's time the surgeon dreaded the almost inevitable consequences of his operation. Lister made surgery so free from risk that we now may say that, with due care in the detailed application of the lessons learnt from him, it is no longer the fatality of the operation itself which is feared. In these days when a patient dies it is not because the operations leads to septic complications which he cannot withstand. We fear for him chiefly, if not only, when the extent of the operation is formidable, or when the most sensitive regions of the body, sometimes remote and almost inaccessible, are attacked by methods which half a century ago were beyond the wildest dreams of the most adventurous mind. Our main concern in these days is with the condition of the patient before and after operation. We seek to make him as safe for surgery as surgery has been made safe for him. Lister, in short, has made all the methods applied by the surgeon almost devoid of risk in themselves. The risks run are dependent upon accessory factors, upon the state of the patient, the nature and extent of the disease, the intrinsic susceptibility of organs, or the anatomical conditions responsible for the difficulties which must be surmounted.

Do we fully realize the implication of all these statements? We are at the end of an epoch, indisputably the greatest in our history, the epoch in which manipulations by the surgeon have been robbed of the prohibitive dangers which formerly repelled. Now when failure comes it is the individual who fails, not the methods of which Lister laid the eternal and unshakable foundations. Lister by his genius recruited an army of surgeons which has gained astounding victories. The human body from crown to toe has for all time become our indisputable kingdom, within which we may come and go at pleasure, undismayed by the pestilences which menaced us before Lister forever subjugated our enemies. Lister is indeed Captain of the Men of Life.

We, who inherit the glorious legacy of Lister, must not be content merely to enjoy and exploit our incomparable heritage. No great teacher measures his success in contemplation of his own efforts. His greatness lies rather in the work which he inspires others to do, in the tradition not of past accomplishment but of future devotion. Traditions are fostered and increased, not by routine observance of ancient ceremony nor by mute obedience to outworn creed, but by active faith forever seeking new truths and exploring new paths, in conformity with the old spirit and with unchanging devotion to the great ideal of which the tradition is the shrine. There is immortality of the tomb, and immortality of the resurrection. The soul of a great teacher is born again in his pupils. We are Lister's disciples. What, then, are we to do with his gift to mankind? We use it already to the immense advantage of the individual sufferer; a therapeutic weapon of unapproached perfection, we are making it, and we must continue in increasing degree to make it, far more than that. After the Great War the statesmen of Europe, moved by the highest ideals, sought, not perhaps wholly in vain, to convert the allied victory into lasting peace. The statesman's ideal is a warless world. War is to end war. Ideals are not so much for capture as for pursuit, and though the statesman may never attain his ideal, yet the happiness and progress of mankind surely depend upon the grim and perhaps endless struggle to reach it. So, too, for us surgery must be regarded as the most powerful weapon of research upon man and animals ever given to our hands; and the end of research is not the cure only, but far better the prevention, of disease.

John Hunter's Conception of Surgery

The oration I have now the honour to deliver was founded 114 years ago as "a lasting mark of respect to the late John Hunter."[3] Let us turn to Hunter, the greatest surgeon of all the ages before Lister, and see how he regarded the art he practised. In the opening lecture of each surgical course, Hunter said to his students,[4] "The last part of surgery, namely, operations, is a reflection on the healing art; it is a tacit acknowledgment of the insufficiency of surgery. It is like an armed savage who attempts to get that by force which a civilized man would get by stratagem." In his "Treatise on the Venereal Disease,"[5] a work more frequently quoted for its glaring errors than for its profound truths, he indicates one of the ways which lead to this ideal, the prevention rather than the cure of disease. He writes: "As disease in general should not only be cured but when it is possible prevented, it will not be improper to show as far as we know how that may be done; for in this disease we can, with more certainty, prevent infection, its origin being known." He then adds, "corrosive sublimate in water, about a grain to 2 to 8 ounces, has been known to prevent the catching of the disease."

Hunter anticipated that a time would come when surgery, gaining much from the general advance of knowledge, might be rendered both knifeless and bloodless. I do not speak with irony when I say that Lister's work has brought us appreciably nearer to Hunter's ideal. It is true that its first effect has been to increase a hundredfold the operations practised, and to cause an advance into territories never before subdued. The advance was timorous, halting, and at first so unsafe that the men who led the thought of their day, whose stubbornness was iniquity, whose changeless idolatry was the worship of the images of their fathers, did not hesitate to demand that he who practised such a deadly operation as ovariotomy should be indicted for manslaughter. Lister so taught us that to-day, with little risk and with incomparable advantage to our patients, we, who are strong in the faith that our fathers rejected, not only attack disease with remedial operations, we also seek out and expose, we inspect and study it in its deepest recesses, and in its earliest structural manifestations, sometimes discovering its cause, or at least its impressive antecedent, and often tracing the lines of its gradual advance. We are at last coming to appreciate the reaction of living organs upon each other. As I have claimed on earlier occasions, we have created and are slowly building up knowledge from which our predecessors were completely debarred, not new science but new vision of an old science: the pathology of the living. This branch of surgical learning will continue to grow, and therein surely lies our hope that surgery may one day help to end surgery, by enabling us to discover how these earliest processes of disease may be inhibited. Some claim this as the era of preventive medicine. Is there not preventive surgery also? Hunter was possessed of an ideal. Lister gave the power to realize it. We, too, wage war to end war. "Pereant arma bellica."

The Allies of Surgery

At the end of a long, arduous, and triumphant surgical campaign we, if we are prudent and foresighted, shall survey our equipment and our arsenals and consider the strategy of our next advance. The military leader of to-day seeks help from every branch of science; the victorious leader is he who best knows where to seek the help of which he is in need, who has the genius early and quickly to perceive how all new knowledge can be best applied to the art of war. Surgery, too, is warfare; its advance is conditioned by contemporary progress in every branch of science, and its virtue lies in the number and the vigour of its allies. Into what alliances, then, has surgery entered with other branches of knowledge?

The science of physics has brought radiology to our aid, and the discovery of the *x*-ray has rendered the living body translucent. After an opaque meal these rays disclose the normal movements of the alimentary canal; and we learn, as in no other way, the functional anatomy of the intestine. Any defect of outline may reveal a structural deformity, and perhaps enable us to make a precocious diagnosis of conditions whose terminal stages when neglected are fatal.

The art of the chemist can be allied with that of the physicist, as the work of Graham, of St. Louis, has shown, with the result that the physiology of the liver, the functional anatomy and the pathological conditions of the gall-bladder, the association of gall-bladder activity with movements of the duodenum, may all be studied by a new method. And this method, in alliance with that of the surgeon, realizes another stage in our advance towards the prevention of gall-stones, themselves a tardy result of insidious changes originating elsewhere. Chemistry lends its invaluable aid in discovering for us the functional activity of the kidneys, and by its investigation into the cholesterin and calcium content of the blood is helping us to understand some of the problems relating to the functional activity of the liver and gall-bladder. Such conditions as acidosis and alkalosis offer impenetrable secrets if chemistry is not brought to our aid.

Physiology by its inclusion in the Faculty of Medicine acquires a double function. It remains a pure science directing its inquiries solely to the advance and perfection of knowledge. But it becomes also an applied science in league with clinical medicine and surgery. As he sees his conquest of knowledge applied practically to the saving of human life, the physiologist will be encouraged to yet closer study of normal and aberrant vital processes in man. He, too, should stand with the surgeon by the bedside. The great gap between the powers of the surgeon and the aid which the physiologist might give would thereby be reduced, and the reproach removed from his science that, in this sense, it is lagging far behind. The surgeon's activities enable him to uncover the hidden mysteries of early structural changes. He offers new opportunities for the study of normal and perverted function to the physiologist, with whom he might inquire into those early functional changes which correspond to, and are caused by, organic disorder. The surgeon seeks earnestly to know what degree of impairment of function is to be attributed to the textural changes which our new methods have revaled to us. The physiologist may tell us much that we are eager to learn of the effects of our manipulations upon the normal activity of tissues, and of the full or imperfect return of function when diseased tissues have been removed. With his help we may learn what without him we may never learn—the significance and the methods of the causation of early symptoms, and the origins of those pathological changes with whose late mutilations we are, unhappily, only too familiar, With our help he has learnt what otherwise he could not learn—that, for example, the spleen by an excessive destruction of red cells may produce a condition of jaundice, and that the removal of the enlarged spleen results in the disappearance of the jaundice, which is thereby demonstrated to be of hæmolytic origin. Physiologist and surgeon are far more often than is realized necessary to each other, and a closer communion should exist between them. Many of the truths the physiologist endeavours to teach can be demonstrated more clearly in the wards than in the laboratory, and are, therefore, because of this human interest, impressed almost indelibly upon the minds of students. The phenomena of cerebral compression, of Traube-Hering curves, of Cheyne-Stokes respiration; the symptoms of hyperthyroidism, and those produced when the secretion of the thyroid gland is diminished or absent; many of the aspects of jaundice, in addition to the demonstration of hæmolysis as its occasional cause, and of the relations between the liver, the spleen, and the bone-marrow; illustrations of the normal and aberrant functions of the kidney; changes in the chemistry and constitution of the blood, may all profitably be discussed in the ward rather than in the laboratory or the lecture theatre. Students would then realize from their earliest days the truth, which later comes almost with a shock, that physiology and anatomy are not fundamental subjects, but are interstitial, and should grow alongside and be incorporated with the facts of clinical medicine and surgery which they illuminate and explain. Interstitial tissue has as one of its functions the carrying of blood-vessels to nourish cells whose activity is dependent upon the richness of their blood-supply. Biology provides the interstitial tissue of surgery; the activity and the growth of surgery depend upon the nourishment which biology may bring. Unless surgery calls in the aid of all the sciences with which biology is related it will remain as static as ancient geometry, whose figures were drawn once for all. Modern geometry is concerned with function, with the variations of movement by which a figure is described. Surgery's concern in the future will not only be with the states produced, with established organic disease, but with the help of its allies it will eradicate some of those variations in function by which perhaps they have been caused, with which they are associated, and by which their presence is declared.

If sometimes we blame Sharpey and his school for the unhappy cleavage between anatomy and physiology,[6] we must at least acknowledge the great debt we owe to him for laying so firm the foundation of new methods for the studying of functional anatomy in man and in animals. Physiology, with its offspring biochemistry, has introduced physical and physiochemical methods; methods of quantitative observation which have supplemented where they have not supplanted the merely qualitative methods. The brilliant work of Sherrington, Lucas, and others upon the nervous system gave us fresh conceptions of it; further advances along their lines were becoming difficult until the application of thermionic valves made it possible, by recording the transmission of impulses in the afferent nerves, to investigate the effects of stimuli upon the sensory end-organs. And in the interpretation of symptoms, a study to which my old friend James Mackenzie bent the strength of a most eager and original mind, physiology alone can read the occult significance. In acute pancreatitis there is, as Halsted,[7] a great benefactor of mankind, first told us, a lividity of the face. Why? Is it due to some disordered action of the respiratory system imposed by the closeness of the affected organ to the diaphragm and the structures which lie above it, or is there circulatory stasis, or alteration in the blood pigment?

Physiology is the master of all the methods by which these three possible causes may be quantitatively investigated. Estimations of the oxygen saturation of the arterial blood give information of disturbance of respiratory function; information which we may compare to that derived from a measurement of the amount of blood-urea when the renal functions are deficient. Estimations of the carbon dioxide combining power of the blood are essential if we are to recognize the presence and the degree of acidosis. Circulatory stasis may be gauged by the ethyl iodide method of measuring the circulation rate. Alterations of the blood pigment are detected by the spectroscope, and quantitative estimations of abnormal pigments are readily made after the method of Hartridge.

Like the physiologist the bacteriologist is engaged in work which is ranged alongside our own. The more he discovers of the offensive powers of bacteria and of the defensive mechanism of living flesh under their attack, the nearer are we brought to our surgical ideal. The alliance between bacteriologist and surgeon has been necessary for the proof that the true estimate of an antiseptic is not measured only by its bactericidal value tested in the laboratory, but also by its power to encourage the blood serum or the tissues themselves to ward off and to break up an attack. Hunter, with the crude methods which were all he had at his disposal, demonstrated the tryptic power of wound discharges and anticipated a part of the admirable work of Almroth Wright during the war. Who could have imagined, when Lister's work began, that to-day we should be able to keep tissues alive in our laboratories, breeding them and growing them in captivity, separating the one kind from the other, noting the influence which one type of cell is able to produce on its neighbours, and thus coming by the kind of knowledge which John Hunter so earnestly sought, a knowledge of the intrinsic processes of growth and repair? The problem of malignancy is now installed in our laboratories, and the cancer cell is being compelled to yield most reluctantly some of the complex secrets of its Bolshevist behaviour.

The old art of vital staining, which Hunter learnt from Belchier, of Guy's, has taken on new improvements; by means of suitable dyes we can now select special elements in the living body, trace their movements, and note their conduct. The experimental embryologist, too, can help us if we seek to know in what manner the various tissues of the body come into existence.

These, then, are the allies of surgery in the Great War: biology in all its branches, chemistry, physics, radiology. Never before has the master surgeon had such bountiful resources at his disposal. He cannot afford to neglect a single one of them. The urgent problem of our time is therefore a dual one. We must seek to determine the line of advance which surgery will trace in the years ahead, increasing and strengthening our alliances; and we must earnestly discover how the leaders of our army of advance are to be trained. Are the old methods which in their day served so well still enough, or is the form of warfare already so changed, and now so rapidly changing, that a new discipline and a wider knowledge are needed?

Hunter and Lister

To answer these questions we must look backward, and, calling upon our past experience, seek in the records of our great masters not so much what their knowledge was, but what methods they pursued as they qualified themselves for great leadership. We shall find at once that Hunter and Lister, incomparable among surgeons, each put himself through a long and arduous training, never resting in his inquiries as to the activites of living matter, as to its behaviour in health, and its reactions in disease. At the threshold of our survey we recognize that the activities of our two leaders are not unrelated. Hunter's professional life covered the latter half of the eighteeneth century, Lister's the corresponding half of the nineteenth century; between them there intervened two generations of surgeons. My distinguished predecessor, the late Sir Rickman Godlee, who gave this oration in 1913, tells us in the life of his uncle Lord Lister[8] that "Hunter was Lister's greatest hero," that "his copy of Palmer's life of Hunter was marked in many places by pencil notes which show that he was studying it at least as early as 1855," that "a proof of Sharp's engraving of the portrait of Hunter by Reynolds, which had belonged to Syme, hung in his study," that "he always spoke of Hunter with reverence." Further, if we turn to the paper[9] which Lister read to the Medico-Chirurgical Society of Edinburgh in March, 1858, on the "Causes of the Coagulation of the Blood," we find evidence of his early admiration of Hunter. "The nearest approach," he wrote, "which I have been able to find to such an observation (that blood which is retained in the smaller veins of the body remains uncoagulated) is contained in that inexhaustible treasury of original observations and profound reflection, the works of John Hunter."

If I may borrow a simile from the football field to express the relation of these two great men, I would say that it was Pasteur who made the final pass to Lister possible; it was Hunter's captaincy in the scrum that placed Lister in the scoring position. Indeed, we have to admit that while Hunter's resource in midfield has never been excelled, or even approached, and though the ingenuity with which he worked the surgical ball towards the goal remains unsurpassed, yet when he was in a scoring position and we are counting so confidently upon a "try," the ball is fumbled, and our hopes are foiled. The young surgeon of to-day can learn almost as much from Hunter's mistakes as from his triumphs.

The Career and Work of John Hunter

Let us now examine the discipline to which John Hunter submitted himself to attain his leadership. He is the "Dick Whittington" of British surgery. In September, 1748, at the age of twenty, he left his home, an upland farm in the parish of Kilbride, eight miles to the south of Glasgow, and travelling on horseback he entered London in a little under a fortnight, alighting in Covent Garden, where his brother William kept a school of anatomy. William Hunter was beyond doubt the foremost medical teacher of his time; his best pupils caught from him the spirit of research. Among his inspired disciples were John Hunter, William Hewson, William Cruickshank, Charles White of Manchester, and William Hey of Leeds, the founder of the Leeds Infirmary, the first stone of which was laid in 1767 by Edwin Lascelles, the first Lord Harewood. In 1751, after three years of study, John Hunter counted himself a qualified surgeon; he remained in his brother's school to teach and to research, at what salary we cannot now tell, but assuredly it was a small one. John Hunter thus entered the critical years of his life, for the career of a young surgeon was determined then, just as it is to-day, not so much by his conduct during the years of pupilage, as by the use made of the period after qualification. The problems which a young surgeon first attacks, and the methods he employs to solve them, are suggested to him by the age in which he lives and by the school in which he has been trained. In John Hunter's youth a knowledge of the human body was being extended by a skilled use of the art of injection. And so we find him in his earlier years following arteries to their ultimate termination, tracing the course of lymphatic vessels, unravelling the structure of the testis and the kidney by means of an expert use of the injecting syringe and of the hand lens. He remained in his brother's school teaching and researching until the spring of 1761, when he entered his thirty-fourth year.

Here is a list of the subjects he investigated during that period. He began to note the earliest stages in the developments of the chick,[10] and continued this study to the end of his life, deriving from it guidance for the interpretation of the phenomena of repair and of disease. We find him exposing the thoracic viscera, using artificial respiration and noting accurately what happened to heart and lungs when the air-supply was withdrawn and when it was renewed.[11] He studied respiration in birds, keeping cocks alive which breathed through the cannulæ inserted in their air sacs instead of through their windpipes.[12] He carried out a series of experiments on absorption from the bowel in various animals; the experiments were well planned and skilfully executed, but he drew from them a wrong inference, one which misled him subsequently time after time in the interpretation of the processes of disease. He believed that these experiments proved that all the products of digestion were absorbed by the lacteal or lymphatic system and that none entered by the veins.[13] Our hero, as we have seen, was often weak when he approached the goal posts. We find him tracing out the distribution of nerves in the nose and giving, for the first time, the right explanation of why the fifth pair of cranial nerves should enter into the field of mucous membrane supplied by the olfactory nerves.[14] The description he then gave of the descent of the testis[15] and of the vital phenomena which attends that still mysterious operation has never been surpassed. He kept a tame kite to prove that a stomach accustomed to a flesh diet could be educated to deal with one which was purely vegetarian; he noted the phenomena of digestion in the stomachs of fish, fowls, dogs; he explained postmortem destruction of the stomach.[16] He placed pieces of raw meat in suppurating wounds and observed the digestive effects which followed; he measured the digestive (or tryptic) action of pus.[17] We find him deeply interested in the formation of pus upon the unbroken surfaces of serous and of mucous membranes. He began a series of observations on the uses of the vesiculæ seminales[18] and was led thereby to investigate experimentally the potent and mysterious influence which testis and ovary exercise on the development and growth of the body.[19] We find him seeking signs to distinguish between tissues in which life was latent and those from which life had already vanished. He believed he had discovered the organ of hearing in fishes, and sought to discover an explanation of the curious fact that the ovaries of eels were always destitute of ova.

As a collector, like Pascal a "ramasseur de coquilles," who often found a pearl of great price, as an observer of incredible industry, gathering facts just for the sake of their individual value and without at the moment any care for their relative significance, for the effect of their impact upon other facts, he ranks second only to Hippocrates. But when these facts were stored in his mind and illustrated by a series of specimens, he was by no means inexpert in their interpretation or in raising a general truth from a multitude of singular examples. But as we read we seem to be oppressed by the verbal difficulties he encountered. The words will not come. Even the constructive thoughts may sometimes appear to be absent, puny, or unmanageable. He cannot get his mind round them; if by chance we think that he has done so, the splendour of his thought is disfigured by his uncouth language. Abernethy is not alone in telling us of Hunter's paucity of language and of his inaptitude in its use; but we need no other evidence than that which his own works rarely fail to give us. His letters are the same. Illiteracy is not absent from them, though their meaning is often clear enough, especially when express instructions are given. It is when Hunter endeavours to rise to abstract generalization that we see this incapacity chiefly and lamentably displayed. Obscurity of language, I believe, even in abstract matters, often means obscurity of thought. Words may come after thought, but not long after, surely. Hunter's defects in language

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were due in part, no doubt, to the absence of any early education of value, but they were not lessened by his studious avoidance of the work of others. His rebuke to Jesse Foot, as brutal and irrelevant as many of Johnson's, would have confounded anybody, but it is irrelevant nevertheless, and it was a confession of his own imperfection.

After spending fully twelve years experimenting, John Hunter, in the spring of 1761 and in the thirty-fourth year of his age, engaged in the practical work of his profession and was appointed surgeon to the army. In the summer of 1763 he returned to London on half-pay and commenced practice. He bought "a piece of ground called Earl's Court, near the village of Brompton, and two miles from Hyde Park Corner," on which he built a small house. Earl's Court, his week-end cottage, was soon converted into a zoological garden and experimental laboratory; many new problems engaged his mind and several avenues of investigation were opened up there; all of them were made to converge on the same subject—the behaviour of living matter under all conditions. It was not until 1768, when he was forty years of age, that his private practice began to grow, enabling him to take a lease of the house, 42, Jermyn Street, vacated by his brother William. We may now consider him, after an apprenticeship of twenty years, fairly launched in practice. Three years later he considered that his income justified him in undertaking the responsibilities of marriage.

We see, then, this leader of surgery of the eighteenth century devoting twenty years of his life to arduous observation and experiment so as to qualify himself for the practice of his art. There has probably never been a man in our profession with so wide an intellectual interest, so profound a knowledge of so many varied subjects wholly derived from direct personal inquiry and observation. His industry was inexhaustible. He had no equal either as physiologist or pathologist; he was already first among comparative anatomists, and was indeed, one of the founders of this science. He was a naturalist, all subjects in animal and vegetable physiology seeming to attract him. All his unequalled attainments as biologist were brought to the service of surgery, in his hospital work, and finally in the largest private practice of his day. Before Hunter's time surgery was a thing apart, independent of all other sciences, ostentatiously aloof from them, and governed only by the experiences and aptitude gained in the day-to-day practice of the art. All advance was therefore slow, even when recognizable, and was largely empirical. No physiological knowledge, nor any experimental discovery, broadened the old path, or opened up new ones. Hunter changed all this. Not the least of his achievements was that he made alliances for surgery, and linked it inseparably with biology. Hardly a day passed without some experiment. I may quote a statement of his to show how he regarded experiment.[20] "In pursuing any subject, most things come to light by accident; that is, many things arise out of an investigation that were not at first conceived, and even misfortune in experiment has brought things to our knowledge that were not, and probably could not, have been conceived; on the other hand, I have often devised experiments by the fireside or in my carriage, and have also conceived the result; but when I tried the experiment the result was different, or I found that the experiment could not be attended with all the circumstances that were suggested." This statement helps in some degree to explain the number of apparently unrelated subjects which Hunter explored in his younger years. As he opened a new subject he still continued to investigate the old; at the time of his death he had over fifty portfolios in use, each relating to a particular line of investigation.

The "misfortune in experiment" has its counterpart in operative surgery. An interesting little paper might be written on "The Advantage of Error in Medicine." We may recall Spencer Wells's operation for an "ovarian cyst" when tuberculous ascites was found, and the surgical treatment of peritoneal tuberculosis inaguruated. The same distinguished surgeon, a pupil of the Leeds school, operating upon a jaundiced girl of eighteen for "fibroid tumour of the uterus," discovered that the tumour was not pelvic but splenic; he removed the spleen; in a few days the lifelong jaundice was gone, and the surgical treatment of hæmolytic jaundice was begun. So McGill, the pioneer in the operation of prostatectomy, precedence in which is so foolishly claimed for others, removed what he believed to be a "tumour at the base of the bladder." When I, acting as his house surgeon, examined the tumour microscopically and found that it was prostatic, I felt that I had the chance to twit my beloved chief with his error. His reply, when I told him of his mistaken diagnosis, was, "Then why don't we always take the prostate out when it projects into the bladder?"

The Career and Work of Lister

When we compare Lister's preparation for professional leadership with that of John Hunter we are impressed rather by the resemblance than by contrast. Lister, the greatest material benefactor of mankind that the world has ever known, began his medical studies at University College, London, at the age of 21, in 1848, exactly a century after John Hunter had settled down to his work in Covent Garden. In the hundred years that had passed, medical education in London had undergone a revolution; voluntary schools had almost disappeared, to be replaced by the organized schools and colleges with which we are familiar to-day. John Hunter was Scotch, Lister English, his ancestry coming from Yorkshire and Cumberland. John Hunter owed much to his brother, Lister still more to his father, who was not only a successful man of business, but also a Fellow of the Royal Society. William Hunter, who impregnated the mind of his brother, drew his own inspiration and owed his intellectual guidance to the Munro-Cullen school of Edinburgh. Lister was early influenced by William Sharpey and by Wharton Jones, both Edinburgh men, steeped in the traditions of this very school. After qualifying in 1851, and taking the Fellowship of this College at the age of twenty-five, Lister's first research was begun; it was concerned with the contractile tissue of the iris.[21] The injection syringe, the instrument which had served Hunter so well, had been displaced during Lister's youth by the microscope. We rejoice, nevertheless, to notice that when Lister applied this new instrument to the tissue of the iris it was the function rather than the form of this structure which excited his interest. In this investigation, and in another,[22] begun in 1852, "Observations on the Muscular Tissue of the Skin," we recognize that, influenced by William Sharpey, he had become familiar with discoveries made in other countries, notably with those of Kölliker in Germany. But clinical work was not forgotten, and a house surgeoncy at University

College was followed by perhaps the most critical event of Lister's life. In tracing the motives which have directed the progress of medicine we are constantly reminded of the influence and the power of great teachers. Such men are gratefully remembered by posterity, not so much for the work which their own hands or minds have created or have modified; not for their written words which so soon seem to possess little more than an antiquarian interest; not for their spoken words which, though at the moment of their delivery they may walk up and down in the hearts of men and stir them to new thought or to great action, yet seem so frail and cold and lifeless when the morning comes; not for any of these, but for the spiritual legacy they bequeath to those inspired by their own zeal and trained in their own methods to seek the truth in eternal principles. It is this which gives posthumous life, the true immortality.

Not the least of the claims that John Hunter makes upon our reverence is that he was the first founder of a school of surgery. He was not distinguished as a teacher. "He had not the happy talent of displaying the stores of his mind, nor of communicating to others the same perception of the importance of his facts and opinions as he himself entertained."[23] Abernethy said his language was "inelegant and often coarse," "his delivery heavy and unengaging," "his method confused with attempts to find words for thoughts, or else to read from little scraps of paper." Yet despite these unattractive or even repellent qualities, men who themselves influenced surgery for generations afterwards, whose influence still survives, Abernethy, Astley Cooper, Cline, Everard Home, Blizard, all boasted of being his pupils, and taught his method until it became, and still remains, a tradition in their schools, and from them has spread to every school of medicine in the world where Hunter is recognized, unchallenged, as the founder of scientific surgery. My old friend, Dr. Finney, of Baltimore, in his recent address before the Hunterian Society, an address containing much information new to us in this country, speaks eloquently of the germinative influence of John Hunter upon American surgery. He tells us how John Morgan and William Shippen, the founder of the first medical school in America, from which the present medical department of the University of Pennsylvania descends, were "much influenced" by John Hunter; and he adds, "So virile and dominating was his influence that it may readily be recognized and transmitted like other distinguished hereditary traits." And again, "The seed sown by John Hunter is being continually replanted and perpetuated by succeeding generations" in America. Finney quotes Dr. Welch, the intellectual parent of so many sturdy sons, as saying of the "Father of American surgery," "Physick was almost as much a mouthpiece of the doctrines of John Hunter in America as was Abernethy in London." In his *Surgical Memoirs*, J. G. Mumford writes: "The best American surgery grew out of English surgery with Hunter as its prophet." Hunter was the lodestone which attracted men who proved to be the pioneers of surgery in that great country where our Art is practised by its highest exponents with unsurpassed skill and safety. Mumford no doubt remembered that the first professor of surgery in his own University of Harvard was Collins Warren, distinguished son of a distinguished father, a pupil of Astley Cooper, himself the chief of Hunter's disciples, and a teacher who drew men to him from afar. So, in like manner, the debt we owe to Italy must forever be acknowledged when we remember that it was the magnetism of Fabricius that drew the youthful Harvey to Padua. But for Fabricius and the magic of his work, the discovery of Harvey, the great glory of English medicine, might not have been made for generations.

William Sharpey, whose lectures "inspired me with a love of physiology that has never left me," had not only Lister's future, but also all that this meant for mankind, in his own hands when he sent Lister to Edinburgh to the "safest surgeon" of his day, James Syme. It was an almost incredible exodus. When the Hunters came southwards they followed a national habit established for centuries, and never permitted to fall into disuse—a habit which incited the characteristic invective of Samuel Johnson. When Lister went northward he founded a new tradition and made a novel breach in a custom which seemed to have become as firmly accepted as a law of nature. Lister's most distinguished successor in his chair of clinical surgery, my old friend Harold Stiles, made the same adventure, to Scotland's great advantage.

London hardly notes and seems but little disturbed by the arrival and the progress in her midst of young medical men from Edinburgh. (Whatever would she do without them?) Edinburgh, one may suspect, raised her eyebrows when she saw a young doctor from London established as Syme's house surgeon, and she must have rubbed her incredulous eyes when, within two years, she saw him become an extramural lecturer in surgery within her own stronghold. It is quite impossible to exaggerate the importance of this teaching appointment on Lister's future. He met his students—the ultimate number in his first class was seven—on Wednesday, November 7, 1855.

Lister believed, as Hunter had believed, that the beginning of surgery was a knowledge of the process of inflammation; and accordingly he had resolved before his lectures commenced to obtain a new first-hand acquaintance with inflammatory processes as watched in living tissues. Clearly he realized long before the humblest of his intellectual descendants the need to study the "pathology of the living." A frog was caught in Duddington Loch—surely the greatest frog in history, honoured by being made the subject of this research. Why did not someone suggest to Lister when he was granted Arms that this frog should be immortalized in heraldic device? The web of this frog's foot gave all the necessary opportunities for the inquiry. Lister had many new advantages over Hunter; he knew that the tissue he examined was made up of living units—cells! He had at his disposal a powerful microscope, which could mark the behaviour of these cells; and Claude Bernard, in 1853, had taught him the existence of vasomotor nerves. It was during the examination of the frog's web that Lister made a biological discovery of the highest importance—one which experimental biologists are still exploiting—that pigment-containing cells, such as are seen in the frog's web, give more easily visible, and more delicate, reactions than any other kind of living cell when subjected to a physiological or a pathological stimulus. This quality enabled him to study the effects of inflammation in terms of individual cells. He was able to prove that these pigment cells still gave vital responses fifteen days after the leg had been amputated.

The list of researches carried out by Lister between the time of his arrival in Edinburgh in 1853 and his appointment to the chair of surgery in Glasgow in 1860, would almost suggest that he was seeking to fit himself to become an experimental physiologist or pathologist rather than a surgeon. I would earnestly emphasize this point, for its significance in Lister's day was far less than it is to-day, when the full harvest of his work is ready to be gathered. In most of these researches we can clearly see the strong influence of John Hunter. It is not accident surely that the men who have done most for surgery trained themselves rather as research workers than as practitioners, that they revelled in and set out to master one problem after another in biology. Lister's acknowledgment of the immense influence of Hunter upon him is not in the least overstrained. If the spirit of Hunter watches over his museum and this College, as we hope it may, how infinite must be its pride in the thought that the one man greater in service than Hunter himself was his direct intellectual offspring.

Let me recall the names of a few of Lister's early papers: That "On the Flow of the Lacteal Fluid in the Mesentery of the Mouse,"[24] begun in 1853 and published in 1857, is a direct extension of Hunter's experiments on absorption;[25] the communication on "The Persistent Vitality of the Tissues"[26] is founded upon observation made by Hunter himself on the same subject. The studies on "Coagulation of the Blood" began by observing what happened in the veins of "sheep's trotters" taken from the shambles. By devising new and critical experiments he was able to carry the knowledge concerning coagulation to a point far beyond that which Hunter and Hewson had reached a century before him. Yet his methods were clearly modifications of theirs. Lister's vocabulary, indeed, was still that of Hunter, for he spoke of the "solids" of the body, of "preternatural stimuli";

of the "disposition of the tissues"; of "inherent tendencies"; and of "sympathetic irritation."

The events which followed Lister's arrival in Glasgow are too well known to all the world to need more than the briefest recapitulation. Lister was then thirth-three years of age, almost the same age as Hunter when he joined the army as a surgeon. As a result of seven years of a preparatory experimental investigation, conjoined with a wide clinical observation which was closely related to it, he had become immersed in all the problems relating to inflammation and suppuration. He had already formulated a hypothesis that suppuration was due to putrefaction; and in 1865 was ready to put his supposition to a practical test. Pasteur's epochal discovery that putrefaction was due to "germs" set matters going. Lister[27] wrote:

> "To prevent the occurrence of suppuration, with all its attendant risks, was an object manifestly desirable; but till lately apparently unattainable, since it seemed hopeless to attempt to exclude the oxygen, which was universally regarded as the agent by which putrefaction was effected. But when it had been shown by the researches of Pasteur that the septic property of the atmosphere depended, not on the oxygen or any gaseous constituent, but on minute organisms suspended in it, which owed their energy to their vitality, it occurred to me that decomposition in the injured part might be avoided without excluding the air, by applying as a dressing some material capable of destroying the life of the floating particles."

Lister was first of all concerned with the destruction of organisms after they had obtained access to wounds. He knew of the experiments with the Carlisle sewage, and of the bactericidal properties of carbolic acid. He observed carefully the effects produced upon living tissues by antiseptics, and concluded that the reparative processes in a wound were not thereby weakened. We are apt, however, to forget the gradual change that came over Lister's views, and the effect this had upon his practice; how he came to a full realization of the essential powers of defence possessed by the living tissues, and of our obligation to protect and, if possible, to increase them. Sir Rickman Godlee, who knew more of Lister than any man, has written that Lister before 1881, when he first told the world of his changed opinions,

"had long recognized and taught that healthy living tissues exercised an inhibiting influence on the growth of micro-organisms. . . . He therefore began to wonder whether, if only slightly damaged, for example, by the incision made by a very sharp knife, the living tissues of any wound might not be able to deal with a certain number of germs by their own efforts."

This we gleefully observe is a return to Hunter's work in which he recognised the "powers," "disposition," and "action" of living tissues. It may not be inappropriate to quote Lister's own words. He writes[28, 29]:

"The original idea of the antiseptic system was the exclusion of all microbes from wounds." Again, "during the operation to avoid the introduction into the wound of material capable of inducing septic changes in it, and secondly, to dress the wound in such manner as to prevent the subsequent entrance of septic mischief." Again, "In wounds already septic, attempts are made with more or less success to restore the aseptic state." Again, "In speaking of the antiseptic system of treatment, I refer to the systematic employment of some antiseptic substance so as entirely to prevent the occurrence of putrefaction in the part concerned, as distinguished from the mere use of such an agent as a dressing"; and further, "I always endeavour to avoid the direct action of the antiseptic substance upon all tissues."

The distinction between the preventive and the curative use of antiseptics is in many respects that existing between, on the one hand, the power of a germicide as determined by experiments *in vitro*, and, on the other hand, its capacity to destroy organisms when it is introduced among the living and the dead tissues of a wound. In the former there is a direct conflict, a clean fight, between the microbe and the chemical agent. Few or none of the many intervening conditions are present which have to be considered when a bactericide is introduced into a wound cavity wherein there are multitudes of actions and reactions which even now seem very obscure and are so often conflicting.

Hunter's Anticipation of Modern Progress

We may therefore regard Hunter and Lister as bridge-builders; it is out of a multitude of scientific observations, of apposite inferences, and of wide generalizations that such bridges are built, stone by stone, arch by arch. Posterity will perhaps remember only the one bridge, permanent, indestructible, all-sufficing, of Lister. Across that bridge we have swarmed, a triumphant host, and a vast new territory has met our almost incredulous eyes. Hunter was forever building bridges, ambitious in design, firm in their foundations, but always left unfinished. Some day new architects will come and give them the full span which Hunter surely meant them to have. It is remarkable to note how often he anticipated the lines along which we see that modern surgery is making its advance. Cultures of both benign and malignant tissues are now being kept alive by methods which, devised by Dr. Ross G. Harrison while studying the growth of fibres from the nerve-cells of a tadpole, have been rapidly developed by Alexis Carrel. John Hunter, too, tried his hand at experimental embryology. He "exposed the little animal (the chick embryo) by putting it into water heated to about 104° F. just covering the egg" and "hoped to keep it alive by these means and observe in the same chick the whole progress of growth, but it soon died"; therefore, he says, "I was obliged to have recourse to a succession."[30] He was an experimental surgeon, as may be shown from the following quotation[31] from one of his lectures:

> "Here is the testicle of a cock, separated from that animal and put through a wound, made for that purpose, into the belly of a hen, which mode of turning hens into cocks is much such an improvement for its utility as that of Dean Swift when he proposed to obtain a breed of sheep without wool. The hen was afterwards killed and the testicle was found adhering to the intestines, as may be seen in this preparation where the parts are preserved."

He devised and carried out experiments to ascertain whether the growth in a cock's spur is due to a "disposition" inherent in the spur or derived from the constitution of the cock. He excised spurs from the legs of cocks and implanted them in their combs to note the rate of growth under such unfamiliar surroundings. The first vital stain ever used was madder; it was introduced to the notice of biologists in 1764 by John Belchier, surgeon to Guy's Hospital; by its experimental application John Hunter revolutionized our knowledge of bone growth and bone decay.[32] In the hands of Professor A. V. Hill the measurement of heat in living tissues has become the most delicate and certain indication of the nature of their vital reactions. The manner in which living matter reacted to the application of heat and cold, and the degree of heat generated in living tissues, Hunter made the subject of an endless number of investigations, all with the practical view of ascertaining how much or how little should be done to keep damaged human tissues alive.[33] He was, as we have seen, an experimental physiologist and also an experimental pharmacologist.[34] He was a psychoanalyst[35]; he tried to inoculate an ass and bitch with the virus of syphilis.[36] He preached the doctrine of operating at the earliest possible stage of a disease, and placing himself in the position of the patient said, "Nor do I go further than I now think I would have performed on myself were I in the same situation."[37] He performed experiments on the sensitive plant which are now being repeated.[38] These are only some of the points in which Hunter has anticipated modern progress.

I wonder whether the spirit of John Hunter ever visits this museum, the monument to his immortal memory. I feel sure it must. In days to come the spirit of our Conservator, incomparable in knowledge of the museum, fervid in devotion to it, will join his. What talks they will have; and how eager John Hunter will be to see the latest additions to our treasure house! Arthur Keith, most modest of men, will respectfully address our Master as "Mr. Hunter"; but I think it will not be long before it becomes "Jack Hunter" or even, at last, "Jockie." They will look together at the rib of Robert the Bruce and will nudge each other and say, "He, too, was a Scotsman." Keith will display those parts of the viscera of the great Napoleon which are among our prized possessions, and show John Hunter sections of them under the microscope. John Hunter will be greatly puzzled by the microscope. He will wish to have it all explaind to him, how it works and what it does; and he will be filled with wonder when he hears of "cells." John Hunter may remember to have heard of Napoleon, "a fine promising youth."

The joy of Hunter will be to see once again the skeleton of O'Brien, the Irish giant; he will tell Keith, who already knows it all, of his desire and determination to secure the skeleton; of the cost of it; and like good Scots they will shake their heads and grieve at the great expense, which grew larger as the enterprise grew nearer. John Hunter we know was eager to learn the secret of giant growth, but he had searched the huge skeleton in vain. Keith will tell him, "You made a mistake there, John Hunter: you forgot to open the skull; see where I have removed a piece of the vault; give me your finger, put it in here, and feel this pituitary fossa. Do you notice how large it is? Here is the great secret; the little gland which lies hidden there regulates our stature, and perhaps with other ductless glands not only controls the rate of growth of the individual but even the birth and the destiny of nations."

Perhaps Paget will be listening to them, and now and again he may break silence, to concentrate the experience of a lifetime of activity in pathological research and surgical practice in a sentence or two of incomparable eloquence.

And soon I think Keith will lead John Hunter to this portrait of Lister and leave him to gaze on it. They both will see in it what Henley saw: "the soft lines of tranquil thought." Hunter will hear of Lister's

> "faultless patience, his unyielding will,
> Beautiful gentleness and splendid skill";

and he will agree that "his wise rare smile is sweet with certainties."

And he will hear with something akin to incredulity the marvellous story of Lister's work, and rejoice that one greater even than himself arose in England to serve the Science he had created and loved so well. Hunter will surely be moved to deepest emotion when Lister tells him that his own written word had given inspiration to his most distinguished follower. And we can almost hear what Lister would wish to say to this. "John Hunter, it is you who are the great Master, it is you who raised surgery from barbarism to Science; it was you who inspired me and guided me and taught me. I was always your humble, devout, and most loving disciple."

Visions of the Future

So much for the past in its relation to our greatest men. What of the future? Looking forward I humour my fancy and indulge my dreams. Imagination, Keats tells us, may be compared to Adam's dream—he awoke to find it truth. The art of the surgeon is the pillar of his science, and it is for science to discover how that almost perfect art may now be used to the fullest advantage. We eagerly await the day when disease shall not require to be checked in high career, but shall be blighted at its origin, or even denied existence, when our weapons of war shall be laid aside. That day may yet be far away, but already beyond the distant hills we see promise of the dawn. It does not perhaps so much or so deeply concern ourselves as those who soon must take up our task, and lead the hosts whose victory shall attain our high ideal. In due time, and in accord with ancient precedent, this country of ours, the fruitful mother of so many gifted sons, shall raise up in our schools the youths who shall go forth to conquer a crown. They will be best equipped who keep to the course, recall the methods, and are imbued with the ardent spirit of the two famous men whom we praise to-day, the two greatest surgeons the world has ever known.

Our youths must be prepared for self-sacrifice, for arduous discipline, perhaps for the most heart-breaking rebuffs, for the stern or even bitter criticism of their fellows. But there never was a time so rich in promise, so laden with rewards for those who labour with sincerity and truth. They will not travel alone. The whole army of science is in league with them, moving forward with incredible speed, eager to lay at their feet the triumphs of its astounding conquests. The responsibilities which rest on them, the intellectual accomplishments, and the dedication of their lives demanded of them, are enough to cause the stoutest heart sometimes to falter. Yet, armed with the sword of the spirit and the breasplate of faith, they will remember that the happiness of life lies in its responsibilities, that true joy is found in the quest for what may after a weary journey prove unattainable. Ahead lies the noblest of tasks to which they may consecrate themselves; for the lives of men are in their hands, the love, the happiness, the whole welfare of mankind. We need not fear. They will be worthy of their charge. God counts not result but effort.

* The Hunterian Oration delivered at the Royal College of Surgeons of England on February 14, 1927, in the presence of H. R. H. Princess Mary, Viscountess Lascelles.

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BEFORE AND AFTER OPERATION*

THE distinguishing feature of the intellectual life of the last half century has been the progress of science. The advance has been revolutionary. New ideas are to-day expressed in so new a language, new conceptions and changed methods have created so new a vocabulary, that to the scientist of fifty years ago much of the literature of to-day would be unintelligible. In every department of scientific work the advance has, indeed, been stupendous, almost passing belief. Nor is the wonder of it lessened when we compare or contrast it with all that has happened in other departments of intellectual activity. In painting, in sculpture, in the design or the craft of architecture, in literature, we have altered our immediate interests perhaps, and have changed our tastes, but after comparison of our efforts with the ideas and achievements of days gone by we remain, as we were, in a state of profound and reverent humility. In craftsmanship, as we have learned only in the last two or three years, perhaps nothing more exquisite has been wrought by men's hands than the finished perfection of the works which have been hidden for over 3000 years in the tomb of Tutankhamen.

Advance in Surgery

In applied science nothing so beneficent has ever occurred, nothing surely of greater advantage to humanity, than the progress of surgery in the days since Lister introduced his new methods. Of Lister, whose centenary we are shortly to celebrate, it may truthfully be said that no man has laboured so fruitfully in the material service of mankind. He has saved more lives than all the wars of all the ages have thrown away; he has lifted a heavy load of suffering and of sorrow from millions of hearts; his fame is imperishable. So great are the changes which he brought about that none can adequately appreciate them to-day.

The first result of Lister's work was the perfecting of the accepted methods of operation. Operations which had been of formidable danger became safe; recovery was not only more frequent and more rapid, but the severity of an operation and the suffering it entailed were so much diminished that the hindrances to its performance were no longer serious either to the patient or to the surgeon. The operations which had long been practised always with anxiety, and often with remorse, grew more frequent, and of unimagined safety. This led to a notable invention of new methods and their quick adaptation, perhaps after frequent change, to new experiences. Not only were new methods quickly discovered, modified, and steadily improved, but their appropriate application to the conditions disclosed during operation was by degrees fully established. At almost every step embittered controversies arose. The old quarrels as to priority in the invention or modification of methods and of new instruments seem now merely laughable, though at the moment so much was felt to depend upon them and to centre round them. Controversy is the life of scholarship, though, unhappily, acrimony and coarseness are apt to creep in and to soil the contestants.

Among the great adventures and the new enterprises which grew slowly out of improving methods were two which changed the face of surgery. These were, in the first place, the recognition and study of earlier stages in structural diseases than were ever before accessible, and secondly, the institution of plans to search for associated lesions beyond the immediate field of operation as soon as this latitude to the surgeon was made permissible by success. When in any abdominal operation the inspection of structural changes in the organ arraigned was made, conditions were at first disclosed of which neither the eye nor the hand of the surgeon had any experience, nor could the literature of medicine offer any help. Discrepancies were soon recognised between those pathological changes with which the long experiences of the postmortem room and of the museum had made us familiar and those changes seen during operation. And when, unhappily, a patient died, a comparison of the description given by the operator with the conditions found on the autopsy table led to a considerable measure of disagreement. The surgeon was rebuked, not without contempt, for proclaiming the existence of conditions not discoverable to the same extent, or in the same degree, in the postmortem room. And postmortem experience was held to be infallible. It was to counteract this foolish view that I coined the phrase "pathology of the Living," and in exposition upon this text endeavoured to show that it was the condition of the parts during life which it was most essential for us to know if we were to help the living. Death not only changes the lineaments of a man's face, but so profoundly alters the parts affected by disease that the conditions before and after death may seem to be hardly comparable.

A study of the pathology of the living has led to a complete revision of our knowledge of abdominal diseases. Before the surgeon came, our acquaintance with duodenal ulcer as a disease affecting multitudes of men and women hardly existed; a diagnosis of duodenal ulcer apart from its lethal complications had almost never been made. Of gastric ulcer, in respect of pathology, we knew much as a result of the work of Mathew Baillie, Cruveilhier, and Brinton, but the correlation between our pathological knowledge and our clinical acquaintance with the disease was woefully incomplete. The diagnosis of gastric ulcer was wrong in a very large proportion of cases, as the surgeon was quick to discover. So with cholelithiasis. To read the first edition of Fagge's work on Medicine, one of the greatest books ever written and my sheer delight in student days, and to compare what he knew of cholelithiasis with what we know to-day, is to realise the immense gain to clinical medicine which has resulted from the work of the surgeon. Surgery, indeed, is the strongest of all research weapons in the hands of the physician, and posterity, I fear, will not hold us guiltless of the sin of allowing hostility, or imperfect understanding, to grow up between physician and surgeon in this great creative period in the science and the art of medicine. How much more rapid our progress would have been, how much more accurate our labours, what waste of time and effort would have been spared, if, instead of living each inside his own impenetrable ring fence, the physician and surgeon had met on common ground in the interest of the patient. Our only excuse, the only condonation, is that the sin was not so much of our own creation as hereditary.

Visceral Interaction

A further most interesting feature of our extended operative work has been the disclosure of the interaction between the various viscera. We believe now that all gastric and duodenal ulcers are secondary affections; that their cause often lies in an infection elsewhere; and that this infection travelling by various paths may be revealed at the operation which is undertaken primarily for therapeutic purposes. So, too, with the origins of cholelithiasis, and with the causes of acute and chronic pancreatitis, and with their relationship to diseases of the appendix and gall-bladder. The interaction between the liver and the spleen is admirably illustrated by the effects of splenectomy. In cases of acholuric jaundice this operation has in the clearest manner settled for ever the old controversy as to the possibility of hæmolysis as a factor, a causative influence, in cases of icterus. When the spleen is removed in Banti's disease, the terminal stage of splenic anæmia, the effects on the ascitic condition give the clearest proof as to the influence of the spleen upon the liver. The truths so learnt could be mastered in no other way than the way of surgery, by means of an operation which is not only curative, but is also a research method of the highest value. Surgical research demands infinite patience, great insight, dispassionate intellectual integrity, and sound judgment. A great generalisation of relevance not only in surgery but in medicine and in physiology may spring from all these. Experiments of immeasurably less value, of far less difficulty, involving no arduous responsibility, not demanding a sustained clinical observation, when performed upon animals in a laboratory are hailed as scientific achievements deserving and receiving the recognised reward which the Royal Society, a society founded to "improve knowledge," hastens to convey. But when man with his diseases, in all their baffling and manifold relationships, is submitted to inquiry the labour, judged by the standards of its reward, is unscientific! At least I am compelled to draw this lamentable conclusion when I see that no surgeon in active practice to-day is a Fellow of the Royal Society.

Surgery and its Limitations

The mere craft of surgey is now hardly capable of great advancement. It is admittedly rash and dangerous to make such a statement with confident assurance, but I have no hesitation in so doing. If, for example, ulcers or malignant growths in the stomach are to be removed, is it possible to imagine that the mechanics or the artistry of the accomplished surgeon can be changed in any notable degree for the better? There is nothing in the craft of any art so exquisitely beautiful that it can surpass that shown by the skilful master of surgery. To watch such an artist is to realise that only infinite practice, the most solemn devotion to the details of craftsmanship, and a profound sense of spiritual dedication to a high purpose, are capable of creating and so ennobling the work of a man's hands. The results, too, of such labour by the most expert craftsmen, if they have not quite attained, are almost as near to finality and perfection as human effort can make them. This truth surely needs no illustration before such an audience as this. A word of comment and of warning is, however, necessary. Surgery is not learned easily. The training is arduous and protracted; indeed, it lasts a man's lifetime. It must begin under a master's eye and be influenced by his criticism, and not less by his spiritual encouragement. It must not be light-heartedly or recklessly undertaken, nor can it ever be a matter of display.

In recent years, and especially, I think, since the war, the incompetent and ill-trained operator is allowed too free a hand and enjoys too wide a scope. The methods of surgery learned in the war do not fulfil the needs of civil life. The exigencies of war, the haste of war, and the sudden and heavy pressure of urgent work made it necessary to have many operators at once available. Their methods could not, and should not, be the same as those in the deliberate, full, and scrupulous ritual which alone is permissible in our more tranquil daily work. There is today too much bad surgery; surgery performed by those who have, perhaps, some natural skill which has never been trained and moulded to right practice. It is for the student of surgery

> "To act to-morrow what he learns to-day;
> Here, work enough to watch
> The Master work, and catch
> Hints of the proper craft, tricks of the tool's true play."

Our art at least must not be made tongue-tied by authority, but be given the freedom, vigour, and inspiration which come, perhaps insensibly, from contact with great masters. In surgical work craftsmanship is much and knowledge is much, and wisdom, which is the timely and rightful application of knowledge, is more, but as we establish our place in the world it is chiefly character that counts. Much of the inferior work now being done could not continue and would never have begun if the large hospitals today were doing their full duty to the public. There is need of more beds, of new departments, of more lavish equipment, but there is not sufficient money to supply our wants. Debts are heavy, overdrafts are many, waiting-lists are long. The public needs are great and urgent and should be met. We should regard the maintenance of the nation's health as worthy of the first demand upon the public purse and upon private beneficence.

Improvement in Methods

If, then, the mere technique of surgery has almost reached its limits, if no further great development of the power of our hands is possible, how is surgical work to advance? I believe that there is great room for improvement in two directions. We should seek to obtain an earlier access to our patients, and we should use far greater efforts than now seem general to improve the chances of the patient before operation and to help him after the operation is completed. Many patients come to us when their condition is so gravely affected either by the general advance of their disease, by its very nature, or by some sudden complication such as infection or hæmorrhage, that operation upon them cannot be contemplated without the deepest misgiving. Our first thought, and all our efforts must then be directed, not so much to the operation itself as to the resuscitation of the patient. By methods which are growing in number and in value he must be restored to a degree of health and of resistance which, so far as it is possible, will make the operation safe.

An earlier access to the patient is abundantly justified by the success of surgery. The aid of surgery must no longer be withheld until there is otherwise the prospect or the certainty of a loss of life. Relief from suffering is sometimes no less important than rescue from impending death. So many conditions are today allowed to drag their weary way along until the patient is suddenly confronted with a new and far graver peril, or is driven by the misery of suffering, when his health is squandered and spent, at last to seek relief. How is it that chronic duodenal and gastric ulcers are permitted to continue their destructive march until perforation occurs? At least nine out of ten of these perforations should be prevented. Why cannot the surgeon have the chance to help the sufferers from cholelithiasis in earlier stages of their disease? How is it that so very few cases of cancer are seen in an early condition? Every accessible cancer is at first curable. The statistics of the Leeds General Infirmary show this truth beyond dispute. Our cases of cancer of the breast are divided into three classes—

Class I, including cases in which there was no invasion of the axillary glands or of any other tissue than the breast, even at operation or after microscopical examination.

Class II, including cases in which there was invasion of the axillary glands, but in which, apart form the skin over the tumour, there was no other part affected so far as could be ascertained.

Class III, including all other operable cases; cases of deep ulceration of the skin, etc.

The percentage survival after three, five, and ten years is shown by the following figures, given by Miss Gretta Wardle, M.B.:—

	After three years.	After five years.	After ten years.
Class I	88.2	87.5	77.7
Class II	39.5	21.7	15.8
Class III	25.9	3.45	0.0

More cases are operated upon now than formerly, but the increase, unhappily, is almost exclusively among Class III cases. The efforts of the Yorkshire Cancer Campaign, however, are already resulting in opportunities for operation in earlier stages of the disease, and there appears to be a clear obligation upon our profession now to give such general instruction to the public as will make them realise the importance of seeking medical advice for conditions which they have too long regarded as trivial, or have ignored. A campaign of public education in matters of health is long overdue. If it is frankly and fearlessly undertaken we shall enlist public understanding and sympathy with the work of our profession, and we shall never again witness the lamentable exhibition of bitter prejudice against our attitude and ideals which recently spread throughout the country. Prejudice is the emotional reaction of ignorance to truth. Let us dispel ignorance. Our case is surely unanswerable.

Before any surgical operation is undertaken we must, in the first place, be sure that mechanical treatment rather than medicinal or any other form of medical treatment is necessary or preferable by reason of its greater expedition or greater safety. In the second place, we must ensure that the patient is in the best physical and mental condition to undergo operation. In the third place, we must pay great regard to the exact appropriateness of the procedure employed to the conditions disclosed. And finally, we must not be content to believe that our interest in the patient ceases if he survives the operation, or on the day when his wound has soundly healed.

When contrasted with medical treatment, an operation is often considered as the method by which a new risk to the patient is being added, and little thought, if any, is given to the far greater risk from which the patient is, perhaps, being rescued. If a patient chances to be the victim of a disease which causes a good deal of discomfort, even it may be a formidable degree of temporary suffering, yet does not, on the whole, greatly impair the general or physical efficiency, and does not appear to be a grave menace to life, it may well seem that an element of danger is being introduced when an operation is mentioned. We have, however, to recognise that the safety of surgery has become so assured that its methods may be employed, and are daily employed, not only for the rescue of a threatened life, but for the relief of recurring pains, discomforts, or any other forms of physical disability. But there is something far more important than this, something which requires the most positive statement, and it is this: that surgical treatment for many diseases is not only more effective than medical treatment, it is far safer. In my little book on Gastric and Duodenal Ulcer I review ten years' work in the operation theatre, and I discuss the material available from the postmortem room over the same period of time. The irresistible conclusion must be drawn that by comparison with surgical treatment in competent hands, medical treatment is so dangerous in the chronic form of these diseases that fresh and far sounder arguments for its continuance, or for any reliance to be placed upon its permanent effects and value, must now be brought forward. Medical treatment having been faithfully tried in one or two attacks of gastric or duodenal ulcer, and having failed, a repetition of the treatment will be followed by a higher mortality than is now associated with surgical treatment in skilful hands, and the chance of permanent relief is not to be compared with that which surgery affords. And the same arguments hold good with regard to cholelithiasis. The deaths that follow upon surgical treatment are deaths resulting from operations necessarily extensive because of the advanced state of the disease, which must too often be performed upon patients suffering from jaundice, hepatic insufficiency, acidosis, carcinoma, chronic pancreatitis, or some other preventable complication. The early recognition of these diseases should be the quest of the physician. In those stages they may be amenable either to prevention or to relief. In the stage when we see them today there is no skill even of the most practised physician which can do more than render the diseases somnolent, not only ready to awake and create afresh the old disturbance at any moment, but in their slumber to cause changes which hasten a patient to the grave. If the physician instead of a too tenacious hold upon the declared case of cholelithiasis, for example, would seek out the symptoms and the signs of the earliest phases of the disease, its antecedents, or its causes, and so enable us to counteract its origins and to check its development, we should all be happier. Our hospital system, with its most inadequate supply of beds, unfortunately restricts the activities of the physician to the patients whose diseases are advanced. The forward-looking minds in medicine are attracted by the prospects of preventive medicine.

Surgical treatment, in many abdominal conditions, may therefore often truly claim to be speedier and safer than medical treatment, and to be able to restore the patient to a brighter degree of health and to a greater freedom for enjoyment. But it must be competent and careful surgical treatment, carried out by those who have trained themselves to secure the best results.

In the future we must, I think, look for advance in surgery not so much to improved methods of operative technique, as to a wiser application of methods now almost perfected. It is therefore our task to improve surgical judgment, and to that end a long survey of past experience is essential. And it is most necessary for us to devote a greater measure of attention to the preparation and after-care of the patient. Surgery has been made safe for the patient; we must now make the patient safe for surgery.

Blood Transfusion

The procedures by which we lessen the risks of operation are already increasing in number and in efficiency. Among the most valuable I would place the direct transfusion of blood. For my early knowledge on this subject I am greatly indebted to Crile. In the spring of 1908 I paid a visit to him in Cleveland for the express purpose of learning something of his technique, and brought back with me the instruments he then used to anastomose the radial artery of the donor to a vein of the recipient. The method was difficult, and had the disadvantage that we had to judge of the amount of blood given by observing the effect on the receiver or upon the donor, or by measuring the time during which blood flowed between them. The results, nevertheless, were good. From that year onwards I have transfused blood in all needful cases, and there can be no doubt that many lives have been saved thereby, and in many more cases convalescence has been hastened.

Transfusion is used when severe hæmorrhage has recently occurred, as in cases of ulcer of the stomach or duodenum, in splenic anæmia, in fibroid tumours of the uterus, or when carcinoma is present; in cases of anæmia associated with growths in the stomach or colon; in cases of general enfeeblement when the red cells are fewer than 4,000,000. It is also used not infrequently in cases of inoperable malignant disease when deep *x*-ray therapy is being applied, since a considerable reduction in the number of red cells is sometimes found to follow exposure to these powerful rays. As a rule only one transfusion is necessary, but I have on a few occasions given as many as five transfusions. For example, in a very severe case of splenic anæmia which I saw with Dr. G. W. Watson the red cell count was 900,000, the abdomen was full of fluid, and the liver enlarged. Five transfusions of blood brought the count up to 4,300,000; the abdomen was twice tapped and about 30 pints of fluid removed. I performed splenectomy. Convalescence was easy and assured; health and strength were regained, and no fluid has since accumulated within the abdomen. Transfusion may be employed, too, both before and after operation. On many occasions after the operation of gastrectomy, especially for carcinoma or for jejunal ulcer, the transfusion of 15 ounces of blood a few days after operation seems to alter the whole prospect of the case. The patient feels better at once, is more hopeful as to his recovery, and inclines to food for which he may before have felt distaste.

The transfusion of blood has many virtues: the red blood cells seem to act as well in their new surroundings as in the old; they last a sufficient length of time to tide the patient over a crisis; they appear to encourage and, indeed, to cause the red marrow of the recipient to produce red cells more rapidly and in greater number than before; the fluid remains in the vessels far longer than is the case when saline solution alone is infused; and finally, conditions such as the mobilisation of cholesterol, which may be of incomparable assistance in the fight against infections, are at once established.

Postoperative Procedure

Too much has been done by catharsis and starvation to reduce the condition of patients before operation. I encourage patients to drink as much fluid as possible for a day or two before operation, and of all fluids a 5 per cent. solution of glucose appears to be the best for this purpose. And I suppress the philocathartic propensities of nurses. An evacuation of the intestine the evening before an operation is all that is necessary if the patient has been accustomed to a daily action. If constipation has been the habit it is, perhaps, a mistake to change it, or to endeavour to do so, in the last few hours before operation. I am sure that patients suffer far more from flatulence if they have been purged. And the deprivation of fluids after the ardent administration of pills and draughts and enemas is a grave disadvantage to all patients. It is a mistake to begin an attack on the patient by the same ritual immediately after operation upon any of the abdominal viscera. They have been subjected to a rude invasion and are no doubt feeling the affront. Why not leave them alone for twenty-four or thirty-six hours at least until their self-respect is recovered? There is too much meddlesome interference in these matters, both before and after operation, and a great deal of quite needless discomfort is added to the patient's ordeal. There is in the great majority of cases no difficulty in compelling the intestine to act, whenever this is desired, by aperients, enemata, the administration of eserine, or even of pituitrin if there has been intestinal obstruction. The stretching of the anal sphincter after the operation of colectomy, or the introduction of a short tube within the rectum in other cases is often a help in allowing the unimpeded escape of gas.

Blood Examinations in Surgical Work: Acidosis

We are quickly learning the great advantage of blood examinations in surgical work, and we are realising how closely the clinical condition of a patient corresponds with and is explained by the chemical state of the blood. One of the most serious postoperative conditions, formerly almost invariably fatal, is acidosis. It may occur as a sequence to operation upon a dehydrated and starved patient, upon patients who have jaundice or hepatic insufficiency, or whose kidneys work inadequately; or it may occur as a direct consequence of the anæsthetic, especially if choloroform is used. It is some years since chloroform has been given to any patient of mine; it is far too dangerous a drug, and over its late effects, often unrecognised but none the less serious, we have had little or no control until recently.

Acidosis was formerly one of the most dreaded of postoperative complications; now, happily, by foresight and by after-care the risks of it are greatly diminished. The reaction of the blood is always faintly alkaline, and even in extreme degrees of acidosis shews little change: it never, of course, becomes acid. When in the body fixed acids, oxybutyric acid, and diacetic acid are produced they are at once combined with the sodium bicarbonate of the blood as a result of the "tampon action" of Bayliss, and carbonic acid is produced. The respiratory centre being extremely sensitive to this acid is stimulated, respirations are increased, and the pulmonary ventilation throws off the acid until the original relationship of bicarbonate of soda and carbonic acid is restored. In this reaction bicarbonate of soda has been used up, and there is consequently a diminution of the alkali reserve, and there results that "modification of the normal equilibrium between acids and bases whereby the power to neutralise acids is diminished," that is acidosis. There are other buffer substances in addition to bicarbonate of soda; the blood-cells may lose their potassium and sodium to the plasma and so help to keep the balance between acids and bases. So far as elimination is concerned the power possessed by the kidneys to excrete acid salts and to leave behind a part of the base with which the acids are in combination is one of high value. By the intestinal canal phosphoric acid is excreted. The loss of equilibrium between acids and bases may clearly be due, not only to increased production of acids which engage a larger quantity of bases, but also to a primary deficiency in the alkali reserve, or even to a combination of these two conditions, hyperacidity and hypo-alkalosis. The acids produced in excess are intermediate products in imperfect fat katabolism. The incineration of fats is set alight by carbohydrates, and a deficiency in carbohydrates is therefore the main causative influence in acidosis; accordingly the indication is to supply more carbohydrates.

The carbohydrate upon which we rely in cases of acidosis is glucose. It is, however, not seldom difficult to administer it, for vomiting is often so constant that none can be given by the mouth; little is absorbed when introduced subcutaneously; and none in sufficient amount, or with sufficient rapidity is absorbed from the rectum in a patient greatly enfeebled. Happily, the intravenous method of administration has proved to be extremely satisfactory. We now adopt the method suggested by Matas of giving a 5 per cent. or 10 per cent. solution of glucose, with or without bicarbonate of soda, continuously, an apparatus being used which maintains a constant temperature. And the glucose is utilised by administering insulin at the same time either intravenously with the glucose or hypodermically under very careful restrictions. Though this method has only been used by us for the last two years it has already proved its high value, and beyond question has saved lives.

The necessity for the control or the prevention of acidosis is at its highest in cases of diabetes. The risks of operation were formerly very high and not infrequently any surgical measures considered desirable were either reduced to the very smallest degree or were postponed or even denied to the patient. In cases of cholelithiasis, for example, I have for this sole reason often known a necessary operation withheld because of the fear of death or of imperfect and protracted healing of the wound. To-day I regard the co-existence of glycosuria and cholelithiasis as a still more urgent call for operation. And there is no longer any doubt that, with care before and after operation, with regular blood examinations as a part of the routine, the risks of surgical treatment are no greater in these cases than in others. It is important to recognise the value of a supply of utilisable sugar in diabetes, and possibly the administration of carbohydrates before operation, together with insulin in quantities sufficient to ensure their assimilation may sometimes be necessary. Fluid must be given generously and catharsis and starvation both avoided. Glucose intravenously and insulin subcutaneously in the proportion of 2 gr. of the former to 1 unit of the latter must be given to the extent deemed necessary, a constant watch being kept on the urine for sugar and diacetic acid. The importance of avoiding any infection during or after operations upon diabetic patients, because of its effect in hastening, or even causing, coma is probably familiar to many surgeons. In such cases insulin appears to have less value than usual. The necessity for dealing actively with infections in those who suffer from diabetes is not less important.

Alkalosis

The opposite condition, alkalosis, is sometimes, though more rarely, a source of anxiety after operation.

Alkalosis is also a result of a change in the ratio of free carbonic acid concentration to bicarbonate of soda concentration. The free acid may be reduced either by increased pulmonary ventilation, or by augmentation of the combining power of the blood plasma with carbonic acid. In either case alkali reserve in the blood is increased, and there is a consequent tendency of the blood to veer more strongly towards the alkaline side. Expressed by Henderson's formula, the blood reaction at any moment depends upon the balance—

$$\frac{\text{Free } CO_2 \text{ concentration}}{NaHCO_3 \text{ concentration.}}$$

An increase in the numerator or a decrease in the denominator indicates acidosis; a decrease in the numerator or an increase in the denominator indicates alkalosis. A change in both numerator and denominator in the same case may at times be observed. Any change in the numerator excites an attempt on the part of the body to compensate by causing an equal change in the denominator and vice versa. In alkalosis resulting, for example, from a greatly lowered CO_2 content of the blood, the compensatory effort takes the form of an increased excretion of alkali and a consequent lowering of the bicarbonate of soda in the blood plasma. If, on examining the blood, this lowered plasma bicarbonate is found, the tendency is to assume that it is due to acidosis. There is, consequently, a danger of confusing the two opposite conditions. They can, however, be distinguished after an examination of the urine. In acidosis there is an increased excretion of ammonia, produced in order to economise the "fixed" alkalis of the blood, whereas in alkalosis the chief need being the riddance of these attacks, ammonia production is no longer required, and is, therefore, reduced to the smallest degree. The two conditions, acidosis and alkalosis, are alike, too, in this—that acetone bodies may be present in the urine in either condition. In acidosis they are in part at least the cause of the condition; in alkalosis they are produced as a part of the compensatory mechanism which seeks to neutralise the excess of alkali.

Alkalosis, then, may result either from an excess of alkali or from a decrease in CO_2. The clinical conditions in which it may occur are:—

1. *Excessive Overdosage with Alkalis.*—The danger of this is small, except, perhaps, in cases in which the renal functions are impaired. Venables reports[1] seven cases of alkalosis following the alkaline treatment of duodenal ulcer. One patient, a male aged fifty, who had suffered for a few months from excessive vomiting, died comatose. He became very depressed, complained of severe headache, of intolerable itching of the skin, and of complete anorexia; he suffered a recurrence of vomiting, and was extremely irritable. The blood-urea was almost quadrupled [was this a case of uræmia?]. Hardt and Rivers[2] relate a similar series of cases of toxicity. Alkalosis has resulted from the administration of sodium bicarbonate in cases of acidosis, especially when associated with poor renal function.[3]

2. *In Certain Gastric Disorders where Free HCl is Diminished.*—For example, in cases of duodenal or gastric obstruction, either accompanied by copious vomiting or controlled by frequent lavage of the stomach, both involving a constant loss of acid. The condition has been produced experimentally by McCann.[4]

3. *In Hyperpnœa due to Increased Pulmonary Ventilation with Excessive Loss of CO_2.*—Alkalosis is accordingly found when there is a want of oxygen, as in those living at high altitudes and in carbon monoxide poisoning. It may follow prolonged immersion in hot water, in consequence of the hyperpnœa induced to keep down the body temperature, and it may be present in cases of high fever. In alkalosis the rise in the carbon dioxide combining power of the blood may increase from a normal of

about 60 per cent. to 120 per cent. or even more, and there is a diminution in the chlorides to nearly one-half of the normal. The blood-urea is raised.

I have only a slight experience with this condition, but I have no doubt that it has been overlooked in my earliest experience, and I should have remained unfamiliar with it but for my colleague, Dr. MacAdam. The difficulty in its recognition is largely due to the resemblance which the symptoms caused by it may bear to those present in acidosis. It is to be feared in those cases where vomiting has been a long-continued and distressing feature before operation. The chief symptom is vomiting, which is both copious and frequent. The stomach may be emptied of a large quantity of fluid and yet fill again very quickly, for within an hour or two severe and prostrating vomiting may begin afresh; headache, generally occipital, is severe and often throbbing in character, and intense dizziness occurs on the slightest movement of the head; there is much pain in the back. Numbness of the extremities appears early with facial rigidity. This is quickly followed by tetany with the characteristic spasm of feet and hands. In the severer cases general convulsions may appear. There is increased electrical excitability and Chvostek's and Trousseau's signs are both present. The patient after a period of irritability will drift into a comatose condition unless the cause of the symptoms is recognised.

The *treatment* consists in supplying fluid by the rectum and subcutaneously, and by the intravenous injection of saline solution in quantities of from one to two pints twice at least during the twenty-four hours. There is a good deal of experience to show that a saline infusion produces only a temporary effect, an effect which rarely lasts for more than six to eight hours, and a repetition of the administration is therefore necessary, and is to be preferred to the injection of a larger quantity on a single occasion. A very dilute solution of hydrochloric acid, one teaspoonful to 10 ounces of water, may be given as a beverage, but the frequency of the vomiting in the acute phase of the condition makes this of little value. With a Jutte tube in the stomach the fluid has a better chance of absorption and may for a time be given in larger quantities; the excess will escape by the tube.

Cholelithiasis

Evidence as to the high value of blood examination is found also in cases of cholelithiasis and of genito-urinary diseases. The work of Dr. Cecilia Shiskin and of Mr. G. Collinson upon my cases of cholelithiasis has shewn that a knowledge of the cholesterol content is helpful in diagnosis. The work of Dr. MacAdam and Dr. Shiskin[5] upon the cholesterol content of the blood in genito-urinary sepsis has shewn how significant a low value may be in demonstrating the need for the rehabilitation of the patient before an operation is undertaken. In such cases the determination of the blood-urea is also of great importance. It is not an extravagant claim to make for these methods that in many cases, perhaps even in a majority, they may prove a more reliable guide than the clinical sense of the surgeon. In the series of 80 cases examined by MacAdam and Shiskin, there were 18 with hypocholesterolæmia, and of these 16 died of pyelonephritis; in only one-half of these cases "did the clinical opinion of the general condition of the patient contra-indicate operation." A low cholesterol content and a large excess of blood-urea indicate the need for delay in operating and for the wise employment of all methods in repairing the damaged health of the patient. Among these methods are continuous slow drainage of the distended bladder in cases of enlarged prostate, a dietary generous in carbohydrates, and the intravenous administration twice, or even thrice, daily of normal saline solution in quantities of one pint on each occasion. The direct transfusion of blood finds useful application here also.

I have realised the possibility of augmenting the cholesterol content of the blood by transfusion; the increase is found to be out of all proportion to the cholesterol content of the transfused blood, and it would seem that there is a quick and lasting mobilisation of cholesterol from the storage deposits in the body of the recipient. This hypercholesterolæmia indicates very probably a strengthened defence against infection. Perhaps no operation in surgery shews so striking a difference between procedures of haste, and of judiciously used delay, as the operation of suprapubic prostatectomy.

Postoperative Results in Jaundice

One of the most satisfactory results of the careful preparation of patients before operation has been seen in those who were jaundiced. Formerly such patients were not seldom denied the relief of surgery because of the grave risks attached to it, and no less an authority than J. B. Murphy advised against operation in cases of carcinoma of the head of the pancreas. One of the disasters which occurred after operation was unceasing leakage of blood from many vessels. On postmortem examinations large masses of blood were found in the peritoneal cavity, in the subperitoneal tissues, in and around the wound, after a great deal had been already lost in the dressings. An examination of the blood shewed a delayed coagulation time. After a visit to Kroneker's laboratory in Berne I began the administration of an alien serum to all jaundiced patients; anti-diphtheritic serum was first tried when needed in haste; afterwards freshly prepared rabbit's serum given in doses of 20 c.cm. twice or thrice repeated. Blood examination before and after shewed a reduction in the coagulation time. It is supposed that the prolonged coagulation time in jaundice may be in part due to a reduction in the amount of calcium in the blood. To reduce this period the administration of calcium chloride by the mouth was first suggested by Almroth Wright, but my experience seemed to show that little or no good came from it. An examination of the blood in a series of 55 consecutive cases of cholelithiasis has shewn that the calcium content is often high. If the normal is assessed at 9 to 22 mg. in 100 c.cm. of blood, 30 patients were found to have a calcium content of over 11 mg., 22 had a normal content, and 3 had a content below 9 mg.; four of the patients were jaundiced; their blood calcium was 9.2, 8.6, 8.6, and 8.1, respectively. If a diagram is made showing the cholesterol content of the blood in cholelithiasis it is found nearly to correspond with a similar diagram showing the calcium content; hypercalcæmia and hypercholesterolæmia almost coincide. To increase the calcium content is not easy. A very slight and a very transient effect is produced by the oral administration of a calcium salt; a very definite and not so transient an effect is produced when 5 c.c. of a 10 per cent. solution of calcium lactate is introduced into the veins; being in crystalloid form the calcium is quickly excreted by the liver cells and escapes into the bile. To counteract the quickly passing stage of calcium increase a repetition of the dose on three or four consecutive days, before and after operation, reduces the coagulation time when this is most needed. (My chemical assistant, Mr. G. Collinson, is responsible for the estimations and for the diagram.)

In jaundiced patients, or in patients in whom there is hepatic insufficiency (the tests for which are not very satisfactory), a direct transfusion of blood, the intravenous administration of glucose, with or without a little

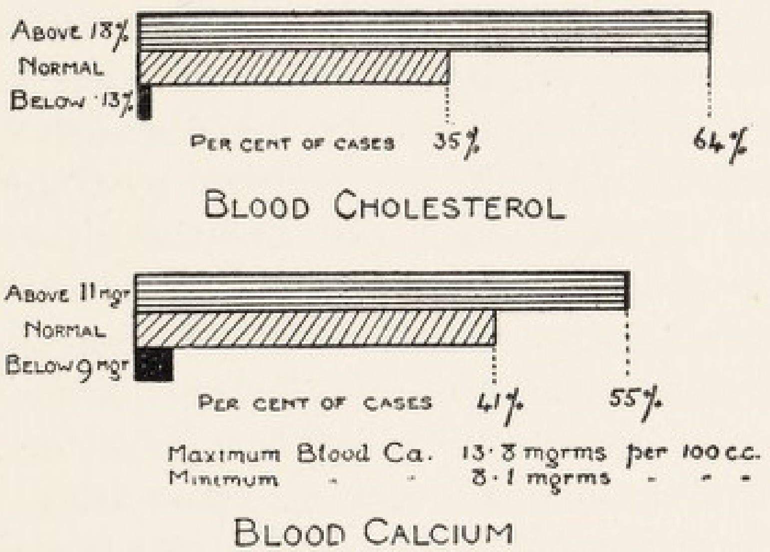

Fig. 1.—Examination of the blood in cases of cholelithiasis to show the cholesterin and the calcium contents.

carbonate of soda, on two or three occasions, or continuously, a very generous carbohydrate diet, and an abundance of fluid by the mouth, all help to lessen the dangers of operation. In such cases chloroform should never be given, and as little ether used as possible. Local anæsthesia with gas and oxygen will often suffice; the surgeon, remembering that it is not his comfort during the operation but the patient's safety that counts, does not ask for a complete relaxation of abdominal muscles.

Vomiting is sometimes a distressing and a dangerous symptom after operation. It may be due to many causes, adynamic or obstructive; it may be the warning symptom of acidosis; it may occur in cases of urgent surgery for acute peritonitis. The moment that it appears to be anything more than the result of the anæsthetic the stomach-tube should be made ready. Early evacuation of the stomach with a little lavage may check the further development; the discomfort caused is amply compensated by the relief which soon follows. If vomiting is frequent, small amounts only being ejected, it is certain that the stomach is overloaded; the tube may evacuate two or three pints of dark fluid. There are times when it is necessary to wash out the stomach repeatedly. In such cases I have found great advantage from the Jutte tube passed through the nose. The tube is very small, weighted at the end; it is easily slipped down the nostril and then swallowed. It may lie in the stomach for days, and the evacuation of fluid may be hastened by the application of a syringe to the other end. One great advantage of it is that the patient may drink copiously while the tube lies in the stomach. This is a very great relief to the patient, and the excess of fluid trickles away by the tube. As Matas has shewn, in cases of high fever, iced water given generously causes the stomach to act as an icebag conveniently placed beneath the heart and over the aorta and vena cava. I have found the greatest help from this tube on several occasions.

Conclusion

My thesis, then, to-day is one with which all will agree: it is that surgery is not only a question of operating. The surgeon in the last generation has had immense and unprecedented opportunity for research. Of these he has not failed to avail himself. He has not only brought relief to countless numbers of patients, but his investigations have created new knowledge, and have corrected old knowledge, as to the causes and conditions of disease. He has become very expert as a craftsman. But more than craftsmanship is needed. It is now his duty to concern himself with all relevant inquiries as to the condition of his patient before operation, to change those conditions to his patient's advantage, and to control his patient after operation, in order that the safety and the permanent success of his operation may be ensured. I foresee, therefore, a change, not only in the aspirations and in the labour of the surgeon, but in the methods by which he is trained for his task. In my day far too much time was spent in anatomy, and a needlessly intricate knowledge of some of its branches was required of us. The years of training might now be profitably spent in learning more of physiology, biochemistry, pathology, and in saturating the surgeon in his plastic years with the faith and the practice of the religion of research. The science of surgery in days to come will be advanced by men trained in the methods and imbued with the spirit of experimental research, though it will no doubt continue to be practised to their profit by those who are merely craftsmen. The surgeon is not simply the tool of other minds; he is not merely required to carry out the mechanical and routine details of a procedure the necessity for which, and the plan of which, others have decided. A life is entrusted to his hands. It is for him to safeguard it. It is he who must finally decide when surgical treatment is needed, and what shall be its scope and application. It is he who must take pains so to prepare or to rehabilitate his patient that the anxieties, the discomforts, and the perils shall fall as lightly as possible upon one who at the moment is perhaps less than ever able to bear them. The surgeon may in some degree share his responsibilities with others, but the chief responsibility must always lie with him, and being his must be exercised not only during the operation but also before, perhaps long before, and also after, perhaps long after, the operation is performed. The operation itself is but one incident, no doubt the most dramatic, yet still only one in the long series of events which must stretch between illness and recovery. The patient, passing through the deep waters, may find them chill and bitter, but the thought of our labour in his service, when the toilsome days are ended, will lie as a glowing coal at his heart.

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* The Harveian Oration delivered before the Medical Society of London on October 11, 1926. Reprinted from *The Lancet*, 1926, ii, 789.

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JOHN B. MURPHY—SURGEON*

"*The moral of the whole story is this: that we should do all that we can to partake of Virtue and Wisdom in this life.*"—Socrates is speaking.

THIS is a day of remembrance. We have come together to do honour to one of the founders of this College, a great surgeon whose loss we mourn. You have laid upon me the duty and the high privilege of offering in your name and in my own, and if I may for the moment assume a wider responsibility, in the name of all the surgeons of his time, a tribute to the illustrious memory of Dr. J. B. Murphy.

John Benjamin Murphy was an arresting personality. Even after the briefest intercourse with him there were few people who did not realise that he possessed a curious and subtle power of impressing a sense of his character upon them. His very handsome face, his tall, spare, almost gaunt figure, his high-pitched and vibrant voice, his burning and quenchless enthusiasm for life in all its manifold activities, his power of complete self-expression, all clamoured for notice, and caught and held the most eager attention. His outlook was grave and serious; he seemed always in earnest. The little quips and sallies, the friendly taunts, the provocations to repartee, the illuminating anecdote, which in the United States distinguish the cordial intimacies of daily life, did not seem to play around him as freely as around other men. Even in a crowded room of busy men, or when a debate was keen he would steal a few moments for a whispered conversation, held aloof, on some topic that for the moment filled his thoughts. Among those who knew him well he was admired and deeply respected, rather than loved. Except to a very few he was not genial or responsive in friendship. His intellectual attainments were so considerable, and his position in the judgment of his contemporaries so secure, that jealousy hardly touched him, except perhaps in his earlier years and from a few among his seniors whose supremacy he challenged. Such jealousy is perhaps the tribute paid to youth for successful enterprise in thought or in action by minds which suffer from the atheroma of advancing years. We are reminded of the aphorism of Sir Walter Raleigh:

> "For whoso reaps renown above the rest
> With heaps of hate shall surely be opprest."

Murphy was beyond question the greatest clinical teacher of his day. No one who listened to him can ever forget the experience. Before his audience arrived he had everything very carefully prepared, diagrams in order, microscopes ready, the patients examined, and all relevant literature at his finger ends. There he stood in the middle of the circle, in the theatre, with his assistants and friends in the first row and the other benches packed to the roof with eager students, or with medical men, who came again and again to learn from him afresh. As he began to speak one felt a strange sense of disappointment, and even of dismay. For while the handsome face and upright figure were things of real beauty, the voice in which he began to speak was quite unpleasant. It was harsh, even raucous, high pitched, shrill, apt to wander into other keys. It seemed strange that a man of Irish descent, and of so gracious and commanding a presence, should have a voice so lacking in softness, one which not only did not appeal, but actually displeased and almost repelled every listener. But as he continued speaking the voice gradually ceased to distract, it became smoother, quieter, and more evenly pitched, and all thought of it was now lost in rapt attention to the matter. For things were happening even while one's first emotions were roused. Questions were being asked and answered, often with great rapidity, then would come a pause, in which with marvellous directness and power the lesson to be learnt therefrom was driven home. The rally began again. A poor answer came, or an assistant responsible for the clinical notes had omitted to inquire upon some relevant point; raillery came in torrents, never ill-natured, never rancorous, but with just sufficient sting to leave a memory which would stimulate all future work. The discussion warmed imperceptibly; gradually the coherent chain of argument lengthened, as link after link, forged under our eyes, newly appeared; slowly there came a sense of excitement; of impending revelation; all inquiry, all disclosure, all arguments, were leading up to something that we now ached to learn. Old observations and ancient truths were taking on a new complexion; relations hitherto unsuspected were here declared and explained. The whole intellectual mechanism underlying a great subject was being shewn both in detail and in all the majesty of many moving parts. Perhaps as we drew near to the end, when the whole story would be laid bare, a question barked at one of his audience would fail to be answered. With voice more clamorous, and almost menacing, with face strained and eager, with figure reaching forward and arm outstretched, he would hurl the question at others. Hearts beat faster, the spiritual anguish could hardly be borne. At last the answer would come, and after a final swift induction or brief summary, when the clinical journey was over, we sank back in happiness and mental repletion to wonder if Stevenson could really have been right when he said, "It is a better thing to travel hopefully than to arrive," for this journey had been happy, though anxious enough, but the haven was a rest of tranquillity, and wonder and content.

And then Murphy would operate. Now of operators there are many types, and, like every other work of art, an operation is the expression of a man's temperament and character. There are still among us "brilliant" operators, from whom I pray to be spared when my hour has come. For them it is the mere quality of effort that counts. Their ideal of operative surgery is something swift and infinitely dexterous, something to dazzle the beholder, and excite his wonder that such things can so be done by human hands. The body of a man is the plastic material in which an artist works, and no art is worthy of such a medium unless it has in it something of a sacrament. Surgery of the "brilliant" kind is a desecration. Such art finds its proper scope in tricks with cards, in juggling with billiard balls, and nimble encounters with bowls of vanishing gold fish. But Murphy was of the true faith. He believed in safe and thorough work rather than in specious and hazardous brilliance. He was infinitely careful in preparation, and compared with many was inclined to be slow; but every step in every operation which I ever saw him do was completed deliberately, accurately, once for all. It led inevitably to the next step, without pause, without haste; that step completed, another followed. "In sequent toil all forwards did contend." And so when the end came, a review of the operation shewed no false move, no part left incomplete, no chance of disaster; all was honest, safe, simple; it was modest rather than brilliant. During the whole operation Murphy talked, not wasting time, but expressing and explaining aloud the quiet, gentle, dexterous movements of his hands and the purposeful working of his mind. The operation over, he would draw his stool near to the front row of the benches, cross one leg over another, rest his elbow on his knee and talk, as only he in all the world could talk, of surgery in general, of this case in particular, of his faults, of any experiment made to clear a doubtful issue. In these quiet talks there was none of the earlier passion which had gleamed through him, and which, caught up by his audience, had made them throb and tremble with suspense or joy. In them all his former experience, all that he had learnt by contact with men and books, all his native ingenuity of mind, were now bountifully displayed; the vast resources of the keenest surgical intellect of his day were now disclosed, not with ostentation or with florid pride, but in such a quiet manner as to shew that he rejoiced in the privilege of sharing with others so many fascinating and wonderful things. If in answer to a request a little intellectual gift were made to him, it was welcomed with frank, almost boyish enthusiasm, and with a delight and humility obviously genuine.

Murphy as a writer and as a speaker was prolific. Whenever he spoke men made haste to hear him. His audience, or so it always seemed to me, were often held back from quick appreciation. He was not like other men instantly attractive as an orator. Yet, as he developed his argument, little by little, and step by step, the audience warmed to him, he interested them, he intrigued them, he dominated them, he fired them; intellectually he roused them to breathless interest; emotionally they were at times at the limit of self-control. No one could bear to miss a word, and while Murphy spoke no man left his seat. For his meaning was conveyed in pellucid language, and though he might speak with the vehemence of raging conviction his thought was never obscured in a smoke of words. Such an intellectual lodestone was he that appointments were missed and hunger and thirst and fatigue were forgotten. For while Murphy expounded his gosepl everything else seemed to fade in importance, overshadowed by the lessons which were now being learnt so eagerly.

I often wondered, as I listened, in what degree he resembled Lincoln. The tall, gaunt frame, and the harsh and meagre and strident voice were the same. Murphy must have been one of the handsomest men of his day; Lincoln's features were haggard, plain, and homely, but his deep and glowing, sad, and tender eyes no man could forget. Murphy had no such command of language as Lincoln, certainly one of the greatest orators who has ever spoken our language. But in effect they must have been alike. For they made everything else seem commonplace when they spoke, and they seemed to be delivering a message charged with truth and pregnant with confidence and hope. Lord Charnwood in his most excellent work on "Abraham Lincoln" writes of him: "His voice when he first opened his mouth surprised and jarred upon the hearers with a harsh note of curiously high pitch. But it was the sort of oddity that arrests attention, and people's attention once caught was apt to be held by the man's transparent earnestness." How exactly was this the case with Murphy also! No one who heard Murphy speak ever doubted his sincerity. One might not agree; one might indeed profoundly and confidently disagree with some statement he made, perhaps as though to provoke a challenge, for there was much in Murphy which justified his patronymic, and which discovered his ancestry; but there was never a thought that Murphy himself was speaking other than his deep and tried conviction. He never looked at truth askance or strangely. One who heard Lincoln speak at Peoria wrote: "Beyond and above all skill was the overwhelming conviction imposed upon the audience that the speaker himself was charged with an irresistible and inspiring duty to his fellow-men." Such an impression was often felt by audiences while Murphy was addressing them.

One thing Murphy lacked; in one respect he grievously failed. If we consider the qualities which go to the making of the greatest surgeons, a foremost place must always be conceded to the capacity to train great disciples. The teaching, the diligence, the general outlook upon surgery, and a finished technical skill can all be drilled into the mind, and imposed upon the methods of an earnest student. But it is the inspiration, the lofty sense of a sacred mission worthy of all the best that is in you, the dedication with humblest and fullest devotion to the cause of scientific truth, and of loyal service to mankind, that are awakened with a thrill in great men by great teachers. It is here that Murphy fell short. He trained no one worthy to be his successor; no evangelist who could carry into other clinics or to other countries some of his glow, his fervour, his complete devotion, or the full meaning of his gospel. For this great omission there were perhaps some compensations. There were few clinics in any part of the world in which something taught by Murphy or inspired by him had not crept in and found a home. His name was often on the lips of surgeons in all lands. His views impressed themselves on men's minds. His methods were closely copied. But when Murphy laid his mantle down there was no one ready and worthy to take it up. When we remember how the pupils of Turner, of Edinburgh, became professors in most of the chairs of anatomy throughout the British Empire, how many men Billroth trained to occupy with great distinction the chairs of surgery in eastern Europe, how Welch is the happy parent of a great school of pathologists trained by him, inspired by him, and looking to him with reverent affection, we cannot refrain from regret that some of the acolytes of Murphy did not grow to the stature of High Priests.

Year by year Murphy grew in intellectual power and in the dominion he exercised over the minds of men. A problem took on a different aspect if Murphy were engaged in it. He touched the common currency of surgical thought and changed it into gold. For no effort of his was meaningless or sterile, and all the powers of his mind and of his frail body were spent ungrudgingly in all his work. His well stocked library, and all new literature were searched for him, and dispatches made for his assimilation. He worked as all great men should work, with a clean desk. His great powers were used for worthy purposes and in due season, nothing was wasted in mere hack work, for all that could be equally well done by others was left for them to do. Yet all his life he overworked. He had an inner restless spirit which drove him at full speed. He must work, and while at work there was only one speed, the highest he could command. "I do not wish to linger after my work is done," he said, and it was exactly what might have been expected from him.

It is useless to wish that men possessed of his qualities and capacities should use themselves differently. A man must do as he must do. If we think that Murphy by spending himself with less lavish extravagance might have prolonged his life another ten years and so have achieved even greater results, to the benefit of all mankind, we are pondering over one who was not Murphy, and who could not in those early fruitful years have been so avaricious for work, or have so generously poured forth the new truths of which he was at once both parent and missionary. Our designs for another man's life are but futile exercises of an imagination lacking in full understanding and adrift from realities.

Such, then, was Murphy as I knew him. It is easy now to see how great a figure he was in the world of surgery of his day. When all his work is reviewed, when not only its range, but the wonderful sincerity and the permanent and piercing accuracy of so large a part of it are considered; when we remember his unequalled gifts as teacher, his power of lucid exposition and of persuasive or coercive argument, his devotion for many years at least to experimental research, it is no exaggeration, I think, to say of him that he was the greatest surgeon of his time. Great men are fitted to their times and in many respects are a reflex of them. But as their times pass their work is seen in far perspective and may appear to shrink in significance. It may then seem to have lost all its originality, and boldness, and force, and we who stand afar off, untouched by the magnetism of a great personality, marvel at its influence in its own day. For there are few indeed who enjoy both celebrity and fame. "Mere talents are dry leaves, tossed up and down by gusts of passion and scattered and swept away; but genius lies on the bosom of Memory." How then will it be with Murphy? Judged by the standard of his contemporaries he was an intellectual giant, but of what stature will he be when judged by the standard of history? May I ask you to bear with me while I pass briefly in review some of the main features of the progress of surgery as science and art, and tell the tale of some of the great men who have laboured in it, from earliest days up to the present time, so that at last we may see how Murphy stands and what figure he will make in the Great Procession.

The earliest remains of man known to exist shew that the art of the surgeon was practised upon him. Wherever skulls of the Neolithic period have been discovered the openings made in them by the trepan are seen. Dr. Marcel Badouin, in 1908, found within a tomb discovered by accident at Belleville the remains of 120 human beings. Eight of the skulls had been trepanned, and the edges of the cut bones were smoothly healed over, showing beyond doubt that the patients survived the operation for periods long enough for this to be fully accomplished. The disk of bone removed is supposed to have been worn as an amulet. The operation of trepanning during the Neolithic period, was also performed in England, in Northern Africa, the Canary Islands, Mexico, and in Peru. It is performed to-day by the natives of New Ireland, to the east of New Guinea, by methods and with results apparently similar to those of the Neolithic Age. Dr. Redman has presented to the Royal College of Surgeons of England a group of five skulls, shewing the effects of the operation, the instruments by which it is there performed, and the dressings applied to the wound. And travellers tell us that the operation is still practised in the ancient way, so far as can be judged, by the Quichuas of Peru. Surgery is therefore as old an art as any.

Hippocrates was the first to give form and spirit to the practice of surgery. His observations even when considered with the fuller knowledge of today often bewilder us by their accuracy, insight, and sagacity. His clinical methods judged by our modern standards were broad-based and structurally sound. He recognized not only the nobility of the art of surgery, and the worthiness of its practitioners, but was well aware of the powerful influence which the craft must exert upon the science of medicine. The divorce of hand from brain which modern custom has worked hard to effect derived neither sanction nor authority from any words of his. As he deals with the outward shewing diseases his clinical method is everywhere the same. He observes, reflects, weighs, and judges, considers his former experience of the like or analogous conditions; he suggests or discovers a general truth; he lays down principles for action, and he tells how the craftsman shall work. If the power of wide and accurate generalisation be, as I believe it to be, among the supremest accomplishments of the human mind, then Hippocrates may in truth be said to have had few rivals, if indeed he has had any, among all those who in later times, and in all countries, have devoted themselves to the science of medicine. For by his injunctions as to the method of enquiry into the conditions of a patient suffering from any disease he lays down for the first time the principles upon which inductive research is founded. He is the parent not of medicine alone, but of the inductive method as applicable to all branches of natural science. It is a proud claim that the method found its first application in the science of medicine.

His observations upon cerebral injuries were hardly bettered until our own day, and many of his instructions as to their treatment cannot be neglected even now. He notes the effect of brain injuries upon the limbs of the opposite side. His work on fractures and dislocations has received praise from the greatest of critics. Littrè spoke of it as "the grandest surgical monument of antiquity," and considered that the truth of its principles was eternal. A century ago the most eminent of French surgeons, Dupuytren, published a work on "Dislocations." Malgaigne, whose familiar name justly carries great weight, judged that, in respect of its discussion of congenital dislocations, the work of Hippocrates was the richer and more accurate. The discourse of Hippocrates on "Wounds," which I read once again in the early weeks of the War, seems to have, in more relations than one, a bearing upon our bitter experience of those most grievous times. Certain it is that for fifteen hundred years afterwards nothing so apt was written, by no one were the essential problems of wound treatment so well understood. The dressings applied to wounds, he tells us, were to be of new materials; water, if not clean and sweet, was to be boiled and strained before use; care of the surgeon's hands and nails was thought most necessary. Oil and wine were the balsam for a bruised or dirty wound, or for one long neglected. The accurate apposition of the wound surfaces and the exclusion of air were means to secure rapid healing by "primary intention," which was clearly distinguished from "second intention." He dreaded amputation of a limb, especially near the trunk: these operations to-day are in respect of their mortality still among the most lethal of all. As Sir John Tweedy has said, "The directions which Hippocrates gives concerning the arrangements of the operating room, the placing of the patient, the position of the assistants, the disposition of the lighting, the care to be taken of the surgeon's hands, the need of ambidexterity, all indicate a careful and experienced practitioner." Hippocrates may count among his greatest glories that he recognized the essential unity of medicine and surgery, or rather that he did not distinguish between them: that he urged and practised the use of all means for the examination of the patient; that he saw no degradation as did so many later ages in the use of a physician's hands in the service of the individual patient, for whose welfare, as Aristotle said, all medicine exists. And his system, which embodied observation, reflection, judgment, all multiplied to make experience which shall decide right action, stands firm until this day. He knew its difficulties, for he tells us that "experience is difficult, verification fallible, observation long and costly, and occasion fleeting." There is one gap, however, a significant one in view of my later contention, in his method. He did not put matters to the proof by way of experiment. The experimental verification or denial of a suggested truth, or the new adventures in thought and action opened up by this method were not for him.

After Hippocrates we may take a long stride in point of time to the days of Celsus, who lived in the reign of Augustus Cæsar. It is interesting to remember that Celsus, the manuscript of whose work, "De Re Medicina," written about 30 A. D., was discovered in 1443 in the Church of St. Ambrose at Milan by Thomas of Sezanne, afterwards Pope Nicholas V, was almost certainly not a physician. He was a noble of the family of Cornelii, who wrote works on medicine, agriculture, philosophy, law, and the art of war, in the spirit of an interested amateur. The deep prejudice of the patricians against the adoption, by one of their class, of medicine as a profession was unconquerable. And the internal evidence in all his writings is opposed to the view that he could have practised as a physician; he mocks at the value of medicine, and esteems the empirical methods of folk medicine as of equal interest and value to the academic methods of his time. He tells us that the true art of medicine lies in the correlation of theory and practice, the one guiding and controlling the other; speculation should guide thought but not determine practice. References to surgical matters are found in all the books, but Books VII and VIII are devoted exclusively to their consideration. The great feature of these is that they record all the changes which had occurred in our art from the time of Hippocrates, and especially inform us of the great attainments of the Alexandrian school in anatomy and surgery. He describes wound treatment in detail; arrest of hæmorrhage in a wound may be effected by packing and pressure, or by the ligature, which finds its first mention in his work. Sutures are to be used to secure apposition of wound surfaces and edges, and, as a dressing, linen bandages are to be soaked in wine, water, or vinegar. He gives in sufficient detail a description of operations for the radical cure of inguinal and umbilical hernia; and for the first time he refers to the removal of the testis as allowing a firmer and more secure closure of the inguinal canal. He mentions translucency as a test for hydrocele, and describes the tapping of dropsies. He quotes a large number of surgical authors, but among them all only Hippocrates is known to us.

It is evident that by the time of Celsus the boundaries of surgery had been sensibly enlarged, that old procedures had been bettered, as in amputations, and that many new ones had been devised. But progress had been along the old lines and was achieved by the old methods. He recorded the multiplication and the magnification of old experiences rather than the revelation of new discoveries. He it was who gave us the fulfillment of the promise of the Hippocratic methods.

But great as were these methods, and considerable as was the success attending their application, there had been a slumber of the intellectual and philosophical aspects of medicine. Hippocrates had united in his own person many divergent and opposing tendencies; after his death there was an acceptance of his teaching by various sects, each adopting a part only, and dogmatism with its cramping tendencies crept in and the spirit of investigation died away. There was need now of a philosopher with new vision, and the need was supplied by Galen. Of Galen's life and character we know much, for he was vain and ambitious, garrulous and verbose. He was trained and deeply versed in all the current philosophies. A dream of his father, Nikon, interpreted as a vision from the God of medicine, decided his choice of a profession. After the death of his father he wandered for nine years, studying in Corinth, Smyrna, and especially Alexandria, which then attracted commerce and patients from all parts of the world. His opportunities were great and his use of them unwearying. He wrote works on anatomical and physiological matters, and attained even in these early years of his a reputation for wisdom and sagacity. For four years he lived in Rome. His learning, his industry, his friendship with the great and the noble, brought him high repute. But the envy of his colleagues, which he did much to provoke, was his downfall and he fled in fear of his life, to return on the invitation of Marcus Aurelius, some twelve years later. But Galen's chief claim to honour, an imperishable one, is that he was the first of physicians to bring experiment to the aid of medicine. As Hippocrates was the parent of inductive method, so was Galen of the deductive. He was the first experimental physiologist. It was he who first discovered and described the cranial nerves, and the sympathetic nervous system; he divided the spinal cord and produced paraplegia; he severed the recurrent laryngeal nerve, and produced the hoarseness and aphonia, which are the constant results of this injury. He discovered the function of a muscle by studying the loss of power which followed its division. He demonstrated the flow of urine from the kidney to the bladder along the ureters, by a series of experiments than which nothing to-day could be more conclusive. And he trembled at the very edge of a great discovery when he wrote: "If you would kill an animal by cutting through a number of its large arteries you will find the veins becoming empty along with the arteries; now this could never occur if there were not anastomoses between them." Unhappily experiment alone did not content him, nor experiment in close alliance with clinical observation. His knowledge of anatomy, unsurpassed by any of his time, did not keep him aloof from the wildest speculations in natural philosophy. It is interesting to learn from him that the art of dissection was mainly, if not wholly, confined to certain families, among whom tradition and instruction give rise to a *caste* of dissectors. The members of a family were, from their childhood, exercised by their parents in dissecting, just as familiarly as in writing and reading, so that "there was no more fear of their forgetting their anatomy than of forgetting their alphabet."

Galen's dissections were confined to the bodies of animals, and the facts so discovered were applied by analogy only to the bodies of men. If a physiological hypothesis charmed him, his anatomical observations had to give way to it. His mind ran riot in speculation, often fantastic and far-fetched, but occasionally shewing a gleam of real insight, as, for example, in his belief that there was a close primary correspondence between the sexual organs of the male and female. But the evils were great and lasting. It was his rash conceits rather than the facts of his experiments, or his sound anatomical knowledge, and broad scientific purpose which were remembered, and indeed almost sanctified, by all men for a period of over one thousand years. Though he was the first of experimenters, he asserted that speculation should lead experience and he exalted a debased metaphysics to a height exceeding that of strict and sober observation. In the times of intellectual stagnation in the Dark Ages the writings of Galen had an unequalled authority; and it was only by a notable independence that Abdollatif dared to assert that anatomy was not to be learnt from books and that even Galen's observations were less to be trusted than the evidences of one's own senses. The result was the sterility and the abasement of medicine until the experimental methods were revived by his direct intellectual descendant, William Harvey.

In a rather different sense, and in a different scene, the great traditions of medicine were handed on by Avicenna, who was born in Bokhara about 980 A. D. It was through him that the works of Hippocrates and Galen became widely known through the East, and finally filtered back to Europe through the Arabs and Moors at a time when learning and culture had almost vanished. The Arabian mind was essentially concerned with compiling knowledge from all sources rather than in initiating enquiry; and a great and useful work, in this direction, was carried out by them during the brightest days of the Saracen Empire. The modern world, indeed, owes much to their careful preservation of knowledge and their multiplication of copies of standard medical works, before the era of printing; even though the science and art of medicine in itself did not, through their efforts, advance one step. In Avicenna we find a mind as keen as that of his great predecessors, viewing the human body and its ailments in his own way, although numerous points of resemblance to the works of Galen and Hippocrates are everywhere evident. He was not an experimenter so much as a philosopher, and the power of his mind over so many later centuries is probably to be attributed to his masterly grasp of all sciences as well as of medicine and surgery. In the art of surgery he can hardly have attained the skill of the great founder, as far as can be judged by the records in the Canon. We do not find all those evidences of mastership in technique which shine so strongly through the writings of Hippocrates. As is characteristic of the Eastern to-day the knowledge which he possessed and, to judge by the records of his successes, utilized with great practical effort, was of a different order, both intuitive and logical, but intuitive before logical. His skill in dealing with fundamental mathematical problems is hardly surpassed at the present day, and in this respect he has been almost the only instance of a great mind applying mathematical concepts to medicine and surgery, up till the present era.

Of other writers before the sixteenth century, it is not unfair to say that they all, or almost all, were merely recorders, encyclopædists it may be, but devoid of any spark of new thought or of wise generalisation. They preserved with reverence the old tradition and the ancient knowledge; they discussed every device, and, at interminable length, the meanings of the old scriptures; they tortured new meanings out of old phrases, they were diligent in dressing old words new, and their scholarship was judged by their ingenuity, or infinite prolixity, in so doing.

The anatomists of the Middle Ages prepared the way of new enlightenment. The oldest treatise on anatomy comes from Egypt. The papyrus dates probably from the reign of Thutmosis I, that is, from before the crossing of the Red Sea by the Israelites. It shews the heart with vessels proceeding from it—the liver, spleen, kidneys, ureters, and bladder. The first of comparative anatomists was Aristotle. The expedition of his pupil Alexander into Asia, which he accompanied, gave him unprecedented opportunities for the study of many animals; the result of his work is contained in several books. The first dissections of the *human* body were made by Erasistratus and Herophilus, of Alexandria. Under the Ptolemies in Egypt were garnered all the fading philosophies and sciences, which amid the dissensions and distractions of life in Greece could no longer flourish there. Alexandria then became the guardian and the host of all the sciences and the literatures of the world. It was here, as we have seen, that Galen learnt much of his anatomy.

After the darkness of succeeding centuries the first gleam of dawn was seen in the University of Bologna. For over one hundred years it had been renowned as a centre of scholastic knowledge, of literature and of law. Mondinus, the father of anatomy as he is always acclaimed, lectured there between 1315 and 1325, and publicly demonstrated the structures of the body as disclosed by dissection. His descriptions are remarkable alike for their extent and their accuracy. The claim has been made for him that he went near to the discovery of the circulation of the blood, for he says that the heart drives or transmits the blood to the lungs. Two centuries later (1514–1564) was born the greatest of all anatomists, Andreas Vesalius, a native of Brussels, a student of Louvain. The difficulties of performing dissections were so great in France that he went to Italy for freer and larger opportunities. "My study of anatomy," he says, "would never have succeeded had I, when working at medicine in Paris, been willing that the viscera should be merely shewn to me and to my fellow-students at one or another public dissection, by wholly unskilled barbers, and that in the most superficial way. I had to put my own hand to the business." When twenty-one years of age he was asked to lecture at the University of Padua. His original additions to the science of anatomy were numerous and of the highest importance. He swept away much of the old "analogical" anatomy, the surmises and the errors, hoary with age, and sanctified by their free acceptance by a multitude of authors in the centuries after Galen formulated them. His work on anatomy is adorned with illustrations which for beauty of design and accuracy of execution have never been surpassed, indeed, I think not equalled, since they were published. It is said that the figures were drawn by Titian. Cuvier remarks that if this be not true they must at least be the work of his most distinguished pupils. But Vesalius did something more than all this. He was the first imitator of Galen in experimental work, and though he did little enough, it was sufficient to show that the method was not utterly forgotten. He was the forerunner of those distinguished Italian anatomists who may share with him the credit for the creation of the science of anatomy, of Eustachius, of Fallopius, who in his short life labored to great ends, and of Fabricius, his successor in the chair of anatomy and surgery of Padua, among whose pupils was William Harvey. The presence of folds in the interior of some veins had been noted by Sylvius and Vesalius and others, and those of the vena azygos were particularly described by Canani in 1547, but it was Fabricius who recognized the existence of valves throughout the venous system and who observed that they were all turned towards the heart.

Harvey had been attracted by the fame of Fabricius to Padua, at a time when Galileo was teaching and was engaging in those methodical researches whose influences have lasted to our own day. Harvey said of himself that he felt it in some sort criminal to call in question doctrines that had descended through a long succession of ages and carried the authority of ancients, but he "appealed unto Nature that bowed to no antiquity, and was of still higher authority than the ancients." It was at the instigation of Fabricius that Harvey undertook by experiment to discover the function of the valves in the venous system, and in the year of Shakespeare's death those experiments whose end was to bring about the greatest discovery in the history of medicine were begun. The discovery had almost been made by half a dozen of his predecessors who appeared to have stood upon its very brink. As Cuvier says, we are often on the edge of discovery without suspecting it. There can be little doubt that the pulmonary circulation had been recognised by the unhappy Servetus, who, with his works, was burned as a heretic at Geneva in 1553 by Calvin.

In 1559, a pupil of Vesalius at Padua, Realdus Columbus, may be said to have suggested the existence of this circulation by inductive reasoning, but to ingenious speculation the minds of men were hardened. It was open demonstration and proof that were needed to press home an opinion so contrary to all accepted teaching.

A discovery is rarely, if ever, a sudden achievement, nor is it the work of one man; a long series of observations, each in turn received in doubt and discussed in hostility, are familiarized by time, and lead at last to the gradual disclosure of the truth. Harvey's discovery was finally due to his application of the experimental method of Archimedes and Galen to a problem of which many of the factors were already known; or, as he himself tells us, the circulation of the blood was held to be completely demonstrated by experiment, observation, and ocular inspection against all force and array of argument. He writes: "When I first gave my mind to vivisections, as a means of discovering the motions and uses of the heart, and sought to discover these from actual inspection and not from the writings of others, I found the task so truly arduous, so full of difficulties, that I was almost tempted to think with Fracastorius, that the motion of the heart was only to be comprehended by God. . . . At length, and by using greater and daily diligence, having frequent recourse to vivisections, employing a variety of animals for the purpose, and collecting numerous observations, I thought that I had attained to the truth."

The reception of this discovery was generous at home; tardy and reluctant, or openly hostile abroad. But it was everywhere eagerly and hotly discussed. Harvey says: "But scarce an hour has passed since the birthday of the circulation of the blood that I have not heard something for good and for evil said of this my discovery. Some abuse it as a feeble infant, and yet unworthy to have seen the light; others again think the bantling deserves to be cherished and cared for. These oppose it with much ado, those patronize it with abundant commendation."

Riolan, distinguished as an anatomist, and professor at the College de France, denied and derided it. What Harvey felt of the opposition may be learnt from his reply to a friend who urged upon him the publication of his later work, *De Generatione Animalium:* "And would you advise me to quit the tranquillity of this haven, wherein I now calmly spend my days, and again commit myself to the unfaithful ocean? You are not ignorant how great troubles my lucubrations, formerly published, have raised. Better it is certainly, at some time, to endeavour to grow wise at home in private than by the hasty divulgation of such things, to the knowledge whereof you have attained with vast labour, to stir up tempests that may deprive you of your leisure and quiet for the future." Nevertheless, compensations and rewards came to him in full measure, and he had the satisfaction of living to see the general acceptance of his discoveries. This discovery, as Whewell said, implied the usual conditions, distinct general notions, careful observation of many facts, and the mental act of bringing together these elements of truth. Boyle wrote: "I remember that when I asked our famous Harvey what were the things that induced him to think of a circulation of the blood, he answered me that when he took notice that the valves in the veins of so many parts of the body were so placed that they gave a free passage to the blood toward the heart, but opposed the passage of the venal blood the contrary way, he was incited to imagine that so provident a cause as Nature had not placed so many valves without design; and no design seemed more probable than that the blood should be sent through the arteries and return through the veins whose valves did not oppose its course that way. That supposition his experiments confirmed."

But the experimental methods of Galen, revived by Gilbert, physician to Queen Elizabeth and the father of modern experimental science, and practised with such supreme effect by Harvey, was to find as yet no place in scientific surgery. That art it is true was practised with wider scope, with confidence bred of generations of experience, and with a risk that was perhaps steadily, though almost negligibly, diminishing. Safety was rather dependent upon the individual capacity of the surgeon than a quality common to the work of all. Richard Wiseman, who was born three years after the publication of Harvey's discovery, is generally granted the proud title of the Father of English surgery. He was a man "given to the observation of Nature," and became Sergeant Surgeon to Charles II and to James II (who when Prince of Wales and Duke of York were withdrawn under a hedge during the battle of Edgehill, October 23, 1642, when Harvey distracted their thoughts by reading to them), and among his contributions to the craft of surgery may be mentioned his operations for hernia, and his advocacy of primary amputation in cases of injury, by gunshot or otherwise, of the limbs.

Ambrose Parè was to French surgery what Wiseman was to British. The life of Parè is one of the greatest romances in the history of our profession; it tells the story of the progress of the son of a joiner who was groom, gardener, barber's apprentice, until he became at last the surgeon to four kings of France. It was he who was concealed, locked up in a room of the Louvre, and spared from death by special order of Charles IX at the Massacre of the Huguenots on the day of St. Bartholomew. For the King said that it was not reasonable that a man who was worth a whole world of men should be murdered. He is the outstanding medical figure in the Renaissance. He was untaught and therefore in youth at least free from the trammels of ancient lore. Early in life he said: "I make no claim to have read Galen either in Greek or in Latin; for it did not please God to be so gracious to my youth that it should be instructed either in the one tongue or in the other." At last, when he read Hippocrates and Galen, he surpassed them both in the number and variety of the conditions he had been called upon to treat; and he was, therefore, the better fitted to approach their teaching in the spirit of an informed and practised critic. "We must not be drugged by the work of the ancients as if they had known all things or spoken all," he writes. Yet in later years he studied diligently, for he was said by Thomas Johnson, who translated and edited his works, to be "a man very well versed in the writings of the ancient and modern physicians and surgeons." He was one of the greatest original minds our art has known, fearless, independent, alert and inventive, and not without a good conceit. "There be few men of this profession," he writes, "which can bring so much authority to their writings either with reason or experience as I can," and again, "I have so certainly touched the mark whereat I aimed that antiquity may seem to have nothing wherein it may exceed us beside the glory of invention, nor posterity anything left but a certain small hope to add something as it is easy to add to former inventions." He won for surgery and for those who practised the craft in France a place they had never before attained.

Surgery was still lacking its firm foundation in pathological anatomy. This was to be built by Morgagni and John Hunter, and by many others taught and inspired by them. The tireless industry, unwearying care, and profound sagacity of John Hunter gave to an art that was largely empirical a warrant based upon a sound knowledge of morbid processes in all tissues. He was observer, investigator, collector, in each capacity without a rival. He was unceasing in his search for truth by way of experiment. "Don't think, try the experiment," he urged his pupil Jenner. In his own person he did both supremely well. His disregard of the written word was deplorable no doubt, but refreshing after so much barren speculation among his forerunners. "I am not a reader of books," he said; and again, "I believe nothing I have not seen and observed myself." His rebuff to one who accused him of ignorance of the classics is famous: "Jesse Foot accuses me of not understanding the dead languages, but I could teach him that on the dead body which he never knew in any language, dead or living." Often he recounts the details of an experiment, but leaves us to draw the conclusion. He changed the whole spirit of practice and placed knowledge on the throne of authority. The day was gone forever when a pure and dangerous empiricism could be practised; surgery became a science and its craft a rational procedure. The museum, which he founded and which still bears his name in the Royal College of Surgeons of England, is unsurpassed in all the world, and his own specimens are still to be seen to bear witness to his incomparable services to pathological anatomy. For Morgagni no praise can be too high. His letters may be read to-day with delight; though his knowledge of disease is, in the modern view, often steeped in mediævalism, his long array of facts and of relevant instances, his description of morbid parts, his accurate and searching generalisations are among the greatest contributions to medical literature in all the ages.

Such was the progress of surgery up to the early years of the nineteenth century. The discovery of the anæsthetic properties of ether and chloroform completely changed the possibilities of the range of application of surgery to morbid conditions and enlarged also the scope of experimental work upon animals. But in every direction the surgeon's work was hampered and frustrated by the occurrence of infection and all its dire consequences, in the majority of the wounds inflicted. It was for Lister that the world was waiting and his coming changed everything. For, as Carlyle said, "The great man was always as lightning out of Heaven: the rest of men waited for him like fuel, and then they too would flame."

Lister, as every one knows, introduced the antiseptic system into surgery. Before his time the wounds inflicted by the surgeon, or those received in civil life as in cases of compound fracture, became septic almost as a matter of course. The decomposition of the wound discharges was formerly held to be due to contact with the oxygen of the air. Lister recognised that the investigations of many observers, ending with Pasteur, which shewed that fermentative and putrefactive processes depended upon minute organisms, were applicable in surgical work also. In the year 1836, a French observer, G. Latour, had pointed out that the tiny particles of which yeast was composed were capable of multiplication, that they were in fact alive, and that it was by their propagation that the change known as fermentation, the change of sugar into alcohol, was produced. Both Latour and T. Schwann shewed that this process could be suppressed by the application of heat to the yeast. Schwann, especially, called attention to the fact that the putrefaction of organic substances was due to these minute living bodies, and that putrefaction and fermentation were essentially one. The weighty authority of Liebig was opposed to this view, and Helmholtz, after a time of wavering, finally ranged himself against Schwann. It was in 1856 that Pasteur began the series of experiments which demonstrated finally that micro-organisms were the cause of fermentation and of putrefaction, and that for each form of fermentation studied by him—yeast fermentation, lactic acid fermentation, butyric acid fermentation—there was one specific cause, and only one.

Lister had long been working on the problem of inflammation and of the decomposition of wound discharges. When, therefore, early in 1865 he read of the work of Pasteur his mind was prepared to receive the new evidence and to put it to the proof in the treatment of surgical cases. It is impossible for us now to realise the horrors and the mortality attached to surgical work at the period when Pasteur's papers were written. In almost every case the discharge from a wound underwent putrefaction; inflammation of varying degrees of severity attacked the wounds, pus poured from their surfaces, and hospital gangrene, erysipelas, and pyæmia, the most desperate form of blood-poisoning, followed with terrible frequency. The clean healing of a wound by "first intention" rarely occurred. A surgeon was more than content, he was eager and gratified, to see a thick creamy discharge of "laudable pus" from the surfaces of a wound. Very few operations were performed, and then, as a general rule, only in cases where death or extreme disability was otherwise certain. Limbs were amputated when smashed, or diseased as to be worthless and dangerous; the mortality from amputations varied from 40 to 50 per cent. In Lister's hands, up to the year 1865, in 15 cases of excision of the wrist-joint by his own method, 6 patients suffered from hospital gangrene and 1 died from pyæmia. Volkmann, one of the earliest of Lister's disciples, had results so ghastly that he decided to close his hospital altogether for some months. Lister's own account of his wards at Glasgow is disturbing and distressing even to-day. The most vigorous and robust patients were swept away after the most trifling injuries or operations, and septic diseases were so frequent and so deadly that the very name of hospital was dreaded by every sufferer. John Bell, a great surgeon, spoke of the hospital as a "house of death."

In the paper which Lister had read, Pasteur asserted that "the most far-reaching of my researches is simple enough, it is that putrefaction is produced by living ferments." He asserted that the oxygen of the air was not the cause of putrefaction, as everyone hitherto had supposed; that indeed some of the causes of decomposition could thrive only in the absence of oxygen. This observation, which distinguishes "aerobic" from "anaerobic" organisms, is of the first importance. Lister at once realised the significance of this work in connection with the changes occurring in wound discharges and on wound surfaces. In 1867 he wrote: "When it had been shewn by the researches of Pasteur that the septic property of the atmosphere depended not on the oxygen or any gaseous constituent, but on minute organisms suspended in it, which owed their energy to their vitality, it occurred to me that decomposition in the injured part might be avoided, without excluding the air, by applying as a dressing some material capable of destroying the life of the floating particles." He proceeded to make trial of the hypothesis in his own work. At this time he had heard also of the experiments made at Carlisle in the disinfection and deodorisation of sewage by German creosote, a crude form of carbolic acid. The administration of a very small proportion of this substance not only prevented all odour from the lands irrigated, but destroyed the entozoa which usually infest cattle fed upon such pastures. This was the preparation he decided, after trying chloride of zinc and the sulphites, to rely upon in his early trials.

Among surgical cases then, as now, the sharpest distinction was drawn between simple and compound fractures; between fractures, that is, where the soft parts are almost unhurt and the skin unwounded, and fractures in which a wound through the skin and soft tissues reaches the broken ends of bone. In simple fractures, life was rarely or never in jeopardy; in compound fractures, putrefaction of wound discharges occurred, septic processes became rampant and the mortality was high. "The frequency of disastrous consequences in compound fractures, contrasted with the complete immunity from danger to life or limb in simple fracture, is one of the most striking as well as melancholy facts in surgical practice." These were the opening words of Lister's first paper on the "new methods" in the *Lancet* in 1867. The first trial of this method proved disastrous, owing to improper management, but the second attempt, on August 12, 1865, proved perfectly satisfactory, and was followed by others which more than realised Lister's most sanguine expectations. Compound fractures healed and united as easily and quickly, and almost as safely, as simple fractures. The method proved by so stern a trial was soon applied to cases of chronic abscess, and by degree to operation wounds. In one of his earlier papers Lister wrote: "Admitting then the truth of the germ theory and proceeding in accordance with it, we must when dealing with any case destroy, in the first instance, once for all any septic organisms which may exist within the parts concerned, and after this is done our efforts must be directed to the prevention of the entrance of others into it." This statement shews that Lister laid down the two essential principles of antiseptic system, the prophylactic and the therapeutic.

Lister's work, it is evident, was the result of research carried out both by the inductive and by the deductive method, and tested and confirmed by many experiments. He combined in full measure the wide, patient, penetrating enquiry, the comprehensive generalisation, and the sound wisdom of the method of Hippocrates, with the demand for experimental illumination or proof afforded by the method of Galen, of Bacon, and of Harvey. He combined in his own work the best of all the schools, and it was no accident that the greatest of all discoveries relating to the science and the art of surgery was made by him.

If a man's services to humanity are the standard by which we measure his value, then Lister may be counted as perhaps the greatest man the world has ever produced. For he has been the means of abolishing, or assuaging, the sufferings of men and women to a degree which is quite incalculable, and, as I said of him years ago, he has been the means of saving more lives than all the wars of all the ages have thrown away.

As the result of Lister's work the way was cleared for an immense and immediate advance in surgical practice, and for an extension into regions that before had been denied even to the most intrepid surgical adventure. The result is known to all the world. Diseases which were beyond the reach of any are now within the grasp of all surgeons. Operations whose mortality even twenty-five years ago was so heavy as to be almost prohibitive are now performed with a frequency and with a degree of safety which never cease to excite our wonder. But Lister's work did something else: it shewed how research for the future must be conducted if our progress were to be both enterprising and safe. It shewed that clinical research and experiment must forever run together.

The achievements of clinical research have been gigantic since Lister's day. The safety which he brought into all our work resulted in an advancement, little by little, of the attack upon the diseases of internal organs, and it exercised in consequence a very powerful ,germinal influence upon internal medicine. If our knowledge of the disease of the abdominal viscera of thirty years ago is compared with that of to-day the truth of this statement will appear. In connection with the diseases of the gall-bladder and bile-ducts the work of Courvoisier published in 1890 is a complete record: it is, indeed, one of the most monumental works ever produced in surgical literature. What was known then, in comparison with now? Nothing of the early symptoms of gall-stones, of the relation between them and visceral and other infections, nothing of the symptoms due to the impaction of stones in one or other of the ducts; almost nothing of the possibilities of safe relief by surgery. Lister's work has not only been the means of relief to the patient in his agony, but has been the instrument by which our own most prolific enquiries into the symptomatology, etiology, and, in no insignificant degree, the pathology of this disease has been made. Of gastric ulcer, as distinguished from cancer of the stomach, our knowledge thirty years ago was trivial compared with what it is to-day. Much of the teaching of those days is not confirmed by the surgical enquiries of to-day; and it is now I suppose admitted universally that unless the physician is guided by the principles of diagnosis discovered by the surgeon and the radiographer he will stray wide from the path of truth. So, too, of duodenal ulcer, our present knowledge of which is due entirely to the clinical research made possible by safe surgery. And the list might be greatly extended. Much more remains to be done. We are only on the threshold of our enquiries as to the complementary action of one organ upon another; of the relations, for example, of the pancreas, spleen, and liver to each other; and of all or any of these to parts, or to the whole, of the alimentary canal, and to the organs possessed only of an internal secretion. Clinical research involves and implies the fullest enquiry into the detailed character of all present symptoms; the most searching pursuit after those earliest departures from smooth and normal action which observation can discover, the correlation of all these with the manifest changes observed at all stages in the several organs during operations upon any of them. When all this knowledge has slowly and patiently been garnered, then the method of experiment must be used to carry our enquiries still further, and to help us to answer the question: "How do these things happen?" Clinical research will tell us of the changes in other organs associated with the one to which our main enquiry is directed, but a process of deduction and an enquiry by experiment are necessary before we can disclose the sequence of events which culminate at last in the disease we set out to study. The clinical research is, beyond question, the more arduous. The factors which enter into it are so many, so variable, so impressed by the changing conditions and moods and circumstances of the patient that only the most indefatigable patience and the most trained capacity can help to resolve the matter into simple terms, to dissociate what may be an infinitely complex grouping of many facts before we can rearrange them in appropriate sequence of process or of time. We must discover the "usual conditions," obtain our general notions, observe carefully a multitude of facts, arrange them in orderly fashion, employ the mental act which will bring them together as elements in a great truth. When this is done, and only when this is done, can the deductive method of Galen be employed to fullest advantage. Experimental research is not so baffling a task. Great ingenuity in the devising of experiments may be found in the supreme masters, Pawlow, Almroth Wright, and a very few others. But each experiment often contains only the one question to which the answer is sought. The answer is "yes" or "no," or is expressed in simple terms, and it is free from those infinite perplexities and changing proportions which distinguish the answer given to any enquiry, even the simplest, in the method of clinical research. When in a simple experiment the answer is given, a new problem may arise suggesting a further experiment. Thus a chain of experiments may develop, each of which answers not only its own question, but contributes in its own degree to the final answer embracing the entire sequence of experiments. The single experiment may be simple. But in respect of a series, each member of which is dependent upon its predecessor, and provokes its successor, and all of which illuminate or decide some problem suggested by clinical research, nothing has been done in surgery comparable to that which in chemistry has been achieved by Fisher and Abderhalden.

These brief glimpses at the progress of surgery shew that its epochs may be considered as three in number.

In the first and longest the writings of Hippocrates and Galen were regarded as an inspired gospel. By them the minds of men were held captive and their imagination enslaved, and every new adventure in thought or action suppressed or cramped. To seek in them for knowledge was all the effort of every man. What was written in them was truth, what was outside them rank heresy. Where the meaning was not as plain as day the most endless enquiry and discussion ensued. The controversies which then shook the intellectual world to its very foundation are seen now to be only laughable, both in their methods and in their quaint decisions. In later ages to challenge the truth or the final revelation of any teaching of Galen's was almost blasphemous, and it required a rare and reckless courage to say, as did Henry of Mondeville, "God did not surely exhaust all his creative power in making Galen." The prophets and seers, who little by little, and with very needful caution, led the world through this black night, death's second self, into the dawn, were the anatomist Mondinus, Vesalius, Fabricius, Fallopius, and others. By their work the assertions of the old scriptures could be openly gauged. In gross anatomy a structure stands out for all to see. If Galen's teaching denied the truth disclosed by dissection, it was most gently and tentatively refuted, heretical and perilous as such a work might be. And as normal anatomy grew it was joined by morbid anatomy, and at last came Morgagni and Hunter. They established the second great era in which the pathology of the dead was studied with a wealth of care and inexhaustible patience. The gross lesions of morbid anatomy, and even many that were recondite and remote, were examined, described, discussed, and arranged in due order by a mighty succession of able men, whose work to-day we too lightly neglect. Clinical medicine and surgery were dominated by the knowledge of the morbid processes discovered in this time. Symptoms were correlated with the signs found upon the postmortem table and upon the shelves of museums. Clinical histories were largely devoted to terminal conditions, for it was only these that brought a patient to a hospital where he died, and where an autopsy could be made. But patients do not die in hospital from the diseases from which they suffer long during life. And in consequence severe limitations were set to our knowledge of disease of all kinds.

Lister's work made possible the third era which depended for its swift and notable advance upon a study of the pathology of the living, upon a study, that is, of morbid processes in their course rather than when their race was fully run. By multiplying observations made during operations we learnt, little by little, how to capture a general truth from a series of individual examples. By slow degrees and quite grudgingly it was admitted that terminal manifestations of disease and the advanced ravages of morbid anatomy did not constitute all medicine; that earlier symptoms were to be referred to earlier changes in organs exposed during the course of operations. And these changes and symptoms we now realise are themselves but late evidence of disease; still earlier manifestations of aberrant action are being sought patiently and with a success that holds increasing hope for future work.

During all these three periods, through Galen, Vesalius, Harvey, Bacon, Hunter, Lister, there has run a vein of experimental work, testing hypothesis and discovering new truths. Since Lister's day there has been a steadily increasing recognition of the value of such work and of the urgent necessity of continuing it, of enlarging its field so that it may be coterminous with medicine itself. We are, indeed, newly entered upon another stage, the stage of combined research, in which clinical observation, inductive and deductive processes of reasoning, and experimental enquiry are linked together. In its progress, so far, the work of a few men stands out as of the utmost significance. Horsley's work upon myxœdema, cretinism, and on the functions of the thyroid gland; Ferrier's, Macewen's, and Horsley's researches upon cerebral affections and cerebral localisation; Senn's work upon the pancreas and upon the intestines; Kocher's work upon cerebral compression and upon the thyroid gland; Crile's work upon shock and upon blood transfusion; and Harvey Cushing's work upon diseases of the brain and the pituitary gland. Since Lister rid all operations upon man and upon animals of their former terrors, many surgeons have turned to experiment in order to perfect and to illustrate their own work, to test an hypothesis, to search for new procedures, or to discover an explanation of clinical phenomena whose meaning was difficult to unravel. In recent days few men have displayed so vast a range of clinical interests, so keen a zest for relevant experimental enquiry, so logical a mind, such frank intellectual honesty as Murphy. He may justly be ranked as one of the earliest and one of the greatest exponents of the method of combined research.

Murphy's first work to attract the attention of all surgeons was that which led him to devise and to perfect the most exquisite surgical implement that has ever been invented, "Murphy's button." Up to the time at which experimental work on the anastomosis of hollow abdominal viscera was begun by Senn, Murphy, and others, the method of securing union was difficult, tedious, and unsafe. I well remember to have seen the operation of "pylorectomy" done in the year 1889. A very niggardly removal of a small "prepyloric" carcinoma was made, and the cut end of the duodenum was united to a part of the divided end of the stomach after the first method of Billroth. We counted over two hundred sutures used to effect the junction. Each suture was of silk; for each the needle was separately threaded, the suture passed, tied, and cut; a wearisome total of movements of the surgeon and his assistants, involving a great expenditure of time. No wonder the surgeons searched for simpler methods. Senn's bone plates, the first mechanical apparatus to assist in an anastomosis, were ingenious instruments not very easy to use, requiring a not inconsiderable degree of skill and patience to secure that the threads holding them were well and truly tied, and calling also for the introduction of a number of additional sutures. The results following the use of these instruments were sometimes very good and sometimes very bad. While surgeons were struggling with this tiresome and unsatisfactory implement, Murphy introduced his "button." It was the result of a great deal of experimental work done upon dogs, in the early hours of the morning, and in the lean years of his early married life. In this work Mrs. Murphy took her share, giving chloroform to the animals. A few people were privileged to know of the boundless help and inspiration which Mrs. Murphy gave her husband in those hard but happy days when he was struggling for his place in the world of surgery. His wonderful success was in no small way due to her sympathy, encouragement, and unfaltering belief in him, and to the eager enthusiasm which she shewed in all his work. His fame was her fame also. As I offer to him my tribute of laurel for honour and of rosemary for remembrance, it is an added pride that I can do so in her presence. With the help of Murphy's button operations, which had been difficult and perilous, at once became so simple that the merest tyro could perform them, and the risk of all operations fell with amazing rapidity. The button was used in every clinic and upon all occasions where visceral anastomoses had to be effected, and the name and the fame of Murphy travelled round the world. But I still think that the great virtue of the button was not in its own direct use, but in the convincing demonstration it gave to us of the essential simplicity of the process of visceral union. By using the button we learned how safely and how rapidly the peritoneal junction took place; there was no need, it was now perfectly evident, for the hundreds of stitches that all surgeons were using. Firm, even approximation for a very few days would lead, the button showed beyond a doubt, to a permanent and secure fusion of the apposed viscera. The button itself was occasionally a danger. After the operation of gastro-enterostomy it sometimes remained for many months in the stomach; when it passed on to the lower intestine it might cause obstruction, or it might ulcerate its way through the intestinal wall. We learned from the use of the button not that the button itself should be used, but all the secrets of the principles of entero-anastomosis. It is not the least exaggeration to say that Murphy revolutionized the methods of visceral anastomosis, and was partly responsible for giving that impulse to abdominal surgery which, in later years, has carried it so far.

A characteristic example of his method of approaching a surgical subject to which he desired to contribute is shewn in his work on "Ankylosis," which he began in 1901. Up to that time the treatment of stiff joints was unsatisfactory, and in cases of severe ankylosis, whether bony or densely fibrous, was almost hopeless. Murphy says he proposes to begin the study of his subject by some questions: "What are joints? What is the embryology of joint formation? What is the pathological histology of acquired arthoses of false joints? What is the pathology of hygromata? (acquired endothelial lined sac) Can they be produced artificially? What is ankylosis? What are the pathological and anatomical changes included in the term? What tissues are involved? From a practical standpoint, into what classes may it be divided? When ankylosis has formed, what are the limitations of surgery for its relief? Can we re-establish a movable, functionating joint with synovial lining? Can we restore motion, and to what degree? In what class of cases can the best results be secured? Can we for the future promise better than the flexible, fibrous unions that we have secured in the past?"

He then discusses the development of joints in the embryo, and the method of bursa formation in early and in adult life, shews that hygromata and ganglia are the products of the liquefaction of hypertrophied connective tissue, and indicates that in an artificial development of joints all the facts relative to these processes should be utilised. The formation of "false joints" as a result of non-union in fractures of the long bones led to the recognition of the pathological condition whose counterpart was provoked in the operation of arthroplasty, in which a foreign body was inserted between the end of bones separated at an ankylosed joint, to prevent reunion and to cause the development of a new joint. He then investigates the matter by experiments upon dogs, and proceeds to demonstrate its efficacy upon men afflicted by bony ankylosis of their joints. The whole piece of work is an exemplary instance of the combination of clinical experience and of experimental research leading to the establishment of a new method of treatment in a severe and most disabling condition.

In 1897, Murphy published his article, "Resection of Arteries and Veins Injured in Continuity. End-to-End Suture; Experimental and Clinical Research," in which, for the first time, he established the principles and described one of the methods of arterial suture and anastomosis. As in other articles, clinical needs indicate the lines of his experimental enquiries, and a widening of the bounds of surgical endeavour and practice is the result. In 1898, he delivered at Denver the Oration on Surgery before the American Medical Association, and chose as his subject the "Surgery of the Lungs." Independently of Forlanini he suggested the injection of nitrogen into the pleural cavity in cases of hopeless unilateral disease of the lung. No enthusiastic acceptance greeted the suggestion. Murphy himself extended the method in his later work to cases of incipient tuberculous disease; and recent experience has fully justified all his claims and has given sanction to his methods. He again combined clinical experience and research by experiment in his work on "Surgery of the Spinal Cord," published in 1907, and his final summary on neurological surgery in *Surgery, Gynecology, and Obstetrics*, 1907, iv, 385, was the most accurate and concise survey of our knowledge of this subject which had then been published.

Wherever we turn we find his method to be the same. A wide survey of the subject to be discussed made interesting by the personal magic that he was able to throw into it; a disclosure of the gaps in our knowledge; a suggestion as to the means by which that knowledge or a want in our technical methods can be made good; a record of experiment to elucidate or to solve a difficult point; a wealth of clinical observation and a formidable array of arguments, lead to an inevitable conclusion stated in terms that none could fail to comprehend. In every article of his that we read we can see the working of an orderly mind, of a mind most eager for new truths, and expectant of them. For every subject he seems to have a mental scaffolding by which he guides and arranges the truths as they are fashioned and duly laid in place. He had a zeal for classifications which looked complex, but when carefully considered tended to simplicity and to easy and ready remembrance. Of his other surgical work, and of his high-minded endeavour to seek for and to secure the purity and advancement of his own profession, I need say nothing. It is a record of sincere and honest devotion to his duty as he saw it before him. Great deeds are born of great zeal and high resolve, and he was lacking in neither. All that he did is within the recent memory of his colleagues here. My immediate purpose has been fulfilled if I have sketched, however roughly, the giant figure of the man and the surgeon whose work was done among you and whose fame has spread out into all lands.

Our calling, by common consent the noblest of any, dignifies all who join its ranks. The honour of the profession is the cumulative honour of all who both in days gone by and in our own time have worthily and honestly laboured in it. In every generation there are a chosen happy few who shed a special lustre upon it by their character, their scientific attainments, or the great glory of their service to their fellow-men; for it is, as Ambrose Parè said, "Beautiful and the best of all things to work for the relief and cure of suffering." In our generation Murphy was one who by his full devotion, his complete surrender to its ideals, and by his loyal, earnest, and unceasing work added distinction to our profession, which, in return, showered upon him the rewards with which no others can compare, the approbation of his fellow-workers and the friendship and trust of the best among his contemporaries in every country.

> "The mightier man, the mightier is the thing
> That makes him honoured."

As we look backward upon the long history of the science and art of medicine we seem to see a great procession of famous and heroic figures, each one standing not only as a witness of his own authentic achievements, but also as a symbol of the traditions, ideals, and aims of the age which he adorns. The procession is sometimes thinly stretched out, or even rudely broken here and there, but in happier ages it is thronged by an eager and exultant crowd. In medicine the whole pageant is as noble and splendid as in any of the sciences or arts, and it reveals the collective and continuous genius of a band of men inspired by the loftiest purpose, and lavish in labour and sacrifice for the welfare of mankind. They have come throughout the ages from every land. They now belong not to one country but to every country, for they are the common possession and the pride of all the world. They have lost their nationality in death. They are men whose deeds will not be forgotten, and whose names will live to all generations. Among such men, few in number, supreme in achievement, John Benjamin Murphy is worthy to take his place.

*The first Murphy memorial oration delivered before the American College of Surgeons, at Montreal, October 11, 1920. Reprinted from *Surgery, Gynecology, and Obstetrics*, 1920, xxxi, 549.

THE DEBT OF PURE SCIENCE TO MEDICINE*

The origin of science is so ancient as to be undiscoverable. The Ahmes papyrus of 1700 B. C., which is founded upon a still earlier work, gives evidence of a knowledge of certain laws of mathematics. The existence even to this hour of the formidable architectural works in Egypt, and of the perfectly proportioned furniture for daily use, is, of course, the clearest evidence that in respect of the laws of physics no small understanding had already been gained. It is, however, to Roman Greece that we owe the concept of the scientific *idea*, the idea that the world in which we live is governed by laws, that the laws can be formulated by a close observation of their methods of working and by their failures to work, and that by experiment the processes by which they work can be tested. Science may, therefore, be defined as the application of methods of observation, of judgment, and of experiment to the physical world. It is the "special application of rational ideas to the known physical Universe."

In the fertile valleys of the Tigris, the Euphrates, and the Nile, the existence of the people and their material prosperity depended in no small degree upon a knowledge of laws gained by the mass experience of the people, upon their recognition of laws of individual conduct and of social relations. Certain rough generalisations based upon these experiences were the first evidences of the existence of a scientific method. And in the same sense that we derive Greek art through Minoan from the Egyptian, so may we derive Greek science from that rudimentary form which was first developed in the valley of the Nile. The founder of the Ionian school, Thales of Miletus (640–550), journeyed to Egypt on affairs of commerce, and gleaning there the embryonic forms of mathematics and of science, returned to Miletus with so great an admiration for them that he abandoned his business to devote himself wholly to their pursuit. And so he lighted the lamp that was to burn so brightly for nearly eight hundred years, then to grow dim for over one thousand years, to glow with renewed and increasing brilliancy down to our own times.

The Science of the Greeks, from first to last, was the child of Medicine. The Hippocratic corpus, springing from a seed planted in still earlier days, grew stronger as it was tended by the hand of the Coan physician. From him all the literature of science is descended. Much has doubtless been attributed to him which is not his own. But his claim to be the first of the scientific writers cannot be gainsaid. In his own work he incorporated all the knowledge of the period, being recorder no less than researcher. In power of accurate observation, in prudence and sagacity of judgment, in breadth of generalisation, he is unsurpassed. To him we owe the method of inductive logic, and it was in the investigation of the problems of Medicine that this method was inaugurated. His careful and reiterated enquiry and observation disclosed certain features in a disease affecting one individual; these features were found to be present in other examples of the same disease. From his knowledge of the conditions present in a small group of similar cases he inferred the general existence of such conditions in all like cases. It is in Medicine therefore that we discover the earliest exercises of the inductive process.

Aristotle attributes to Socrates the elaboration of two logical functions, general definition and the inductive method; but the inauguration of the latter is beyond dispute the gift of Hippocrates to science. The father of Medicine was the parent also of inductive logic. It was especially by his surgery that Hippocrates was led to announce clearly and categorically the first principles of inductive research and practice; namely, phenomena first, then judgment, then general propositions, then practical knowledge and craft. The quarrel as to whether Medicine is science or art has not yet subsided, and will not be silenced till it is recognised that Medicine is fully entitled to rank with both: with science in its enquiries, with art in its practices. Hippocrates and, indeed, all ancient Greek authors speak of it not as an art but as The Art, and he wrote "Where the love of man is there also is love of The Art." And the practice of the art imposed upon its devotees the high character and the austerity of demeanour embodied in the Hippocratic oath, which has set the ethical standard for all later generations. In ancient Greece the practice of medicine was not of unalloyed purity. Side by side with it there was the temple practice of the priests, a debased and superstitious dream-jugglery, the prototype of much of the "spiritual healing" and of the other foolish miracle-methods which disfigure the intelligence of all the later times which have given credence to them.

For us in Medicine Hippocrates then stands for the ideal physician, a man of purest integrity, humane in thought and in every action, the unwearied collector and collator of all truths accessible to the most acute observation; the first to utter great generalisations in reference to any science. The followers of Hippocrates for centuries added nothing to our knowledge of the science or the art of Medicine. They were concerned only with the verbal message he had left for them in the Hippocratic collection, not with the spirit that had possessed him in the long years devoted to his enquiries. So it has often been in Medicine. The great teacher leaves the written word, or the memory of the spoken word, behind him, and these become a gospel, preached uncritically by all the acolytes who have humbly served the high priest. Those who have learned from a great master must surely not be content to imitate his methods, but rather must strive to capture his authentic spirit, and in that spirit to seek for newer and broader roads, and so to discover still firmer truths. There are, perhaps, few nobler virtues than that of loyalty to a great tradition.

In the five centuries that lie between Hippocrates and Galen one great contribution alone is made to medicine, a knowledge of anatomy. It came from the school of anatomists at Alexandria, and its effects on the craft of surgery were considerable. This long stretch of time saw not only the widening of an experience the like of which was already known, but also the addition of many new methods to the art of Surgery. Our authority upon this period is Celsus, a patrician, a dilettante, an acute, eager, and patient observer, but one debarred from practice by his noble birth. For the hands of a noble must not be soiled and defiled by any labour, a lamentable change from the days of Hippocrates, when "in practice as in honour Medicine and Surgery were one."

During the reign of Marcus Aurelius Galen came to Rome. After studying in the school of Alexandria, he wrote on anatomical and pathological subjects, and introduced into the science of Medicine a new method—

that of experiment. It is curious to reflect upon the truth that this first of investigators should also have been the wildest and least trammelled of speculators. And with him speculation governed experiment. Yet the world will forever owe him a heavy debt for bringing into Medicine, and into its ancillary sciences, the method of setting a question and obtaining the answer by experiment. He was the first to divide the spinal cord and to recognise the palsy that followed; to produce loss of voice by section of the nerve to the larynx; to divide a muscle and to note the exact failure of power which was the consequence; to demonstrate the flow of urine from the kidneys to the bladder by a series of experiments than which nothing to-day could be more conclusive. He was therefore the first experimental physiologist. As Hippocrates was the parent of the inductive method, so was Galen of the deductive.

After Galen the world grew dark. The conquests of barbarians, the disruption of the Roman Empire, the debasement of morals, and the degradation of culture led to a period of complete intellectual sterility. Happily for posterity the teaching of the Greeks had reached Asia Minor, and there was preserved by Arab culture through all the centuries till the awakening of Europe and the deep stirring of a new faith.

By these two men, Hippocrates and Galen, each supremely distinguished above his contemporaries, yet each a representative of a long period, there were brought to science the two methods which have ever since rendered its progress possible. The two methods,, induction and deduction, observation and experiment, generalisation and analysis, enquiry and proof, are not of equal value. Of all modern science, Fletcher Moulton has said that where dependent upon the former it crawls, where sought and studied by the latter it advances by leaps and bounds. Yet neither of these methods was to find a firm place in Medicine or in Surgery for many centuries. The estrangement of Medicine from Surgery led to the utter degradation of both, and to an orgy of superstition, of witchcraft, of demonology and astrology, of all the methods by which men, who care nothing for truth and go in fear of it, are even to this day beguiled. The use of Surgery, the very right hand of Medicine, was beneath the dignity of men of birth and breeding. It was restricted to the baser order of men and denounced as vile by the Church. The University of Paris, the very core of the culture of Europe, refused admission to all who worked with their hands. And the Church and nobility scorned such offices as menial. So a craft, neglected and despised by all, was practised only by the meanest of the people. Medicine, its own right arm withered and mutilated, sank into deeper and still deeper ignorance. Galen and all his writings were regarded as immaculate and incontrovertible. To dispute the teaching of Galen was not error only, it was heresy, and might cost a man his life. Garrod has recently reminded us that even as late as 1559 Dr. Geynes was cited before the Royal College of Physicians for impugning the infallibility of Galen and was obliged to sign a solemn recantation of his error.

The dawn of the new day was first seen in Italy. At the end of the twelfth century the peace of Constance had given to Italy the chance to found and richly to endow her schools. Salerno, the oldest of the modern schools in Europe, Bologna with its greater wealth, Padua with its great teachers, all contributed to the awakening and the growth of medicine. It was, indeed, the study of Medicine which furnished the opportunity for the birth of many sciences. Those whose natural leaning was towards chemistry which grew out of the practice of the alchemists, to astronomy which is the truth of astrology, or to physics, found in the study of Medicine their easiest opportunity.

An old teacher of mine, Professor Miall, has said that "the medical school furnished the only regular training for the naturalist, while he found in the medical profession the likeliest means of earning his bread." Medicine has, in truth, proved the fairy god-mother of many of the natural sciences. But the adoption of this form of parentage was tardy. Throughout the centuries, from the peace of Constance to the rise of Vesalius, all scientific effort was reconstructive. No new design was then conceived, rather were all efforts bent upon the interpretation of the unchallenged accuracy of the wisdom of the ancients. Not initiation, but imitation, was the whole scope of every writer. The one science that had never suffered total eclipse, even in the darkest night, was astronomy. The gospel of Ptolemy, based in part upon the false teaching of Aristotle, had never been forgotten. Astronomy indeed was necessary to the Church for the determination of the days of festivals, and to the people for the making of their calendar and for the timely sowing and reaping of crops. Copernicus of Poland, who destroyed the Ptolemaic doctrine and formulated the heliocentric theory, was a physician (1473–1543). He graduated at Crawcow both in arts and in Medicine, and became in due time Professor of Mathematics in Rome. He shares with the anatomist Vesalius the right to be regarded as a pioneer in the new methods, the methods of direct personal observation freed at last from the plagiarisms and the incurable habit of looking backwards which characterise almost all earlier writers. The year 1543 saw the publication of the books by which each is remembered to this day. Galileo (1564–1642), who confirmed the views of Copernicus, constructed his telescope in the year 1609, and published his discovery of the satellites of Jupiter in the following year, was a student of medicine in the University of Pisa. Everyone is familiar with his observations upon the isochronism of the chandelier swinging in the cathedral at Pisa. The standard of time by which he measured was his own pulse; it is curious to remark that Hippocrates nowhere mentions an observation as to the pulse-rate in disease. The revival of the method of Galen and the founding in modern times of experimental science is due to Gilbert (1544–1603), a doctor of Medicine of Cambridge and physician to Queen Elizabeth and to James I. He recognised the obstacles and the inertia against which he was contending in preaching a new faith and in inculcating a new method. For he asks in the preface to *De Magnete*, "Why should I submit this noble science and this new philosophy to the judgment of men who have taken oath to follow the opinion of others, to the most senseless corrupters of the arts, to lettered clowns, grammatists, sophists, spouters, and the wrong-headed rabble, to be denounced, torn to tatters and heaped with contumely?" Galvani (1730–1798), whose name is enshrined, perhaps undeservedly, in the literature of physics, was an Italian physician and Professor of Anatomy at the University of Bologna, where Mondinus had lectured. Among the chemists who were doctors of Medicine have been Robert Boyle (1627–1691); John Mayow (1640–1679); Herman Boerhaave (1668–1738), Professor of Medicine at Leyden; Beccher

(1625–1682), Professor of Medicine at Mentz and physician to the Elector of Bavaria, and Stahl (1660–1734), Professor of Medicine at Halle and royal physician at Berlin, the joint authors of the theory of Phlogiston; and Berzelius (1779–1848), Professor of Medicine in Sweden and greatest chemist of his day. Wollaston (the inventor of the reflecting Goniometer and the early advocate of the theory of Dalton), and Prout (the discoverer of the hydrochloric acid in the gastric juice), both physicians, deserve our special recognition. Thomas Young (1773–1829), the man whose name must for ever occupy the most distinguished place in the history of physical optics in consequence of what he did in reviving and establishing the undulatory theory of light (first suggested by Huyghens), was a physician to St. George's hospital. His work, which, with that of Champoillon, led to the reading of the Rosetta stone, unlocked the mystery of ancient Egypt.

In geology and in mineralogy, Nicolas Steensen, a Dane, (1638–1686) must be reckoned a pioneer. He published a work on rocks and crystals in 1669, and is asserted by no less an authority than Humboldt to be "the first who distinguished between rocks anterior to the existence of plants and animals upon the globe containing therefore no organic remains, and rocks superimposed on these and full of such remains." He was a physician practising in Florence, being known as Steno, and was appointed to the court of two grand dukes. He discovered the duct of the parotid gland which still bears his name. Sir Archibald Garrod writes: "Of him Von Zittel wrote, in his *History of Geology*, that he was the first who sought to solve geological problems by inductive reasoning. He threw much light upon the formation and structure of crystals, and, as Leonardo da Vinci had done a century and a half earlier, he maintained that fossils are the remains of actual animals and plants of former epochs. He ended his life as a Catholic bishop, and his ascetic habits undermined his health. This brilliant Dane is entitled to rank among the great ones of science, as anatomist, geologist, mineralogist, and physician, but his researches, so far in advance of his time, only received their due recognition after much of his work had been done over again by later investigators."

Lister, who in 1683, first constructed geological maps, was a physician; and the first geological museum was collected and systematically arranged by John Woodward, a physician and the pupil of Barwick, physician to Charles II, in 1695. This was bequeathed to the University of Cambridge, where it remains to this day as the nucleus of the "Woodwardian Museum."

Hutton (1726–1797), a protagonist in the long controversy between the Vulcanists and Neptunists between those who maintained the view that all strata above the primitive rocks were deposited by volcanic action and those who believed them to be deposited from the sea, was a doctor of medicine of Leyden. It was he who in the Grampians found a vein of granite penetrating the superincumbent slate, and who thereupon showed so great a delight, such marks of joy and exultation at his discovery that his guides were persuaded that he had "laid bare a vein of silver or of gold."

The close connection between Botany and Medicine need cause no surprise, for the pharmacists were in continuous search for new remedies among the plants and flowers. The belief was universal that for every ill a remedy had providentially been provided, and that where diseases were endemic the remedy would be found near at hand. The first vegetable anatomist was a physician, Nehemiah Grew (1641–1712), who tells us that he was led to the study of this subject by consideration of the truth that both plants and animals "came at first out of the same hand and were therefore contrivances of the same wisdom," and he inferred the probable analogy of their structures. Almost at the same moment similar researches had been undertaken by the celebrated Malpighi (1628–1694), whose name is still in current use in histology, and who was Professor of Medicine at Pisa and at Messina and the founder of the science of microscopical anatomy. He opened the bodies of animals during life and demonstrated what Harvey had inferred, the existence of the capillary circulation. His last years were spent in Rome as physician to Innocent XII. The organizer of the growing knowledge of botany in the early years of the eighteenth century was Linnæus (1707–1778), also a Doctor of Medicine. It has been said that "no man of science ever exercised a greater sway than Linnæus and had more enthusiastic admirers," yet he was not so much discoverer as reformer (a title he claimed for himself), the reformer of the descriptive part of botany and the best order of appropriate terms. He was the forerunner and the inspirer of Rome de Lisle in the science of crystallography.

The influence of Medicine and of the training that a career of medicine necessarily involved has, therefore, been very considerable in the creation and in the development of many of the natural sciences. Yet for several centuries the growth of Medicine hardly kept pace with the slowest of its intellectual children. For, despite a few but most conspicuous exceptions, the methods were sterile methods; they were deliberately designed to search the ancient written words, and were timorous or disdainful of contact with the raw truths of daily experience. A search in the Canon law, however industrious and however ingenious and protracted, can reveal nothing that is not therein contained. Criticism, exposition, interpretation, correlation of any text, however honoured, can never lead to discovery; no creative act is thereby involved. And Medicine for generations was turned in upon itself and sought no new experience.

It is not difficult now to see some reasons for this long delay. In organic diseases there are structural changes in the tissues. These structural changes had never yet been studied with care because of the indignity of manual employment, nor had any of the morbid parts been submitted to examination by the microscope. The science of pathological anatomy created by Morgagni (1682–1771) and by John Hunter gave for the first time the opportunities of correlating the symptoms observed during the lifetime of a patient with the changes found on examination of the body after death. To examine these changes in a living patient was not possible, for every wound was serious, and any opening of a body cavity almost inevitably fatal. Lister's work, founded upon and inspired by the work of Pasteur, made all surgical procedures safe, and gave to Surgery the strongest weapon ever forged, not only for the relief and cure of the disease, but also for the pursuit of a purposeful enquiry into structural changes in the bodies of those afflicted by disease, in an early stage of the morbid processes. So at last the two methods of scientific enquiry, after so long a divorce, came together. Observation could be tested by enquiry into the pathological changes then present; and analogical research could now safely be conducted upon the bodies of animals.

The tendency in modern Medicine is unhappily threatening to go astray. The methods of experiment, necessary though they are to all right and rapid progress, have been given an undue relative importance, and have been regarded as the chief, or even the only, means by which truth can be discovered or established. In the physical sciences, observation, hypothesis, and experiment are, perhaps, the whole story; and of chemistry, which seems more and more to become a province of physics, the same is true. In other sciences experiment may play no great part, our knowledge being chiefly gained by observation, and by a steady, if slow, progress from individual and isolated truths to a universal law. Of such geology is, perhaps, the best example. In Medicine there should be a close confederacy between observation and experiment; but in observation there lie difficulties far greater than in any other science, and in experiment we may often argue only by an analogy. To observe with accuracy in the physical sciences is a matter which chiefly concerns the trained observer: the cold facts presented are there, without distortion and free from gloss; power of perception and of interpretation, patience and strict intellectual integrity on the part of the recorder are the chief qualities required. In Medicine the conditions are not presented with the same simplicity. The symptoms, and even sometimes the signs of disease, are coloured by the personality of a patient, and may be hidden behind a veil that at first seems quite impenetrable. To elicit a true anamnesis demands, not seldom, the most inexhaustible patience, the most acute perception of relevancies; an accurate measurement of those deflections from truth which are the unconscious results of a patient's temperament or fleeting emotions; the re-examination of first impressions in the light of later revelations; each step being taken without prejudice. All this is more anxious and more difficult than any placid observation carried out in the laboratories, and needs a different, and I hold, a far sterner training. The close and continued observation of a multitude of facts, at first apparently disjointed and irrelevant, each captured only by surmounting difficulties that may baffle one repeatedly; the exercise of an unbiased faculty of reason upon all these until each takes its true place in the series; the combination of observed and appraised truths into an accurate diagnosis or prognosis may require the full exercise of the powers of the mind. The Hippocratic method still finds an arduous and its noblest use in the science and in the art of medicine. When so much has been won from ignorance each step in the progress may then be tested, illustrated, or explained by experiment. We must, as Harvey said, seek out the secrets of nature by way of experiment. But again, it is only observation that discovers exactly where the secrets lie, what the experiment should be, and precisely what it is asked to explain. Yet experiment upon animals in the laboratory touching any knowledge gained by contact with the disease of man may be open to error. Such experiment is necessary upon a scale far larger than any upon which we in this country are permitted to engage. The lessons to be learnt are innumerable and of high value. But we must not repeat the error of Galen and argue "analogically" with too ready an acceptance of the accuracy of the analogy. Experiments may and do reveal much of the intricate processes of physiology, but in pathology their value is a little restricted. So many factors enter into the origin, the course and the interpretation of disease in man, that nothing exactly similar can be expected to occur in animals. This warning seems necessary. For, close as the relationship between laboratory methods and clinical experience should continue to be, we must not fail to recognise that it is clinical experience which must govern our decisions, and that laboratory methods are chiefly necessary as auxiliaries and as illustrations rather than as final and controlling influences. We have not proved ourselves free from the grave error of allowing the clear and irrefutable evidences of clinical experience to be placed in a position of subservience to the disclosures of the laboratory. The proof of the validity of laboratory works in connection with human diseases is not their success in the test-tube or retort, but in the effects witnessed when applied to the patient in clinical work. The physician or the surgeon must needs pay due regard to all the help that can be gained by the researches, the tests, the relevant experiments of the laboratories; but the right appraisement of the value of each, and the use of the knowledge so placed at his disposal, are his responsibility alone. For a disease is not the sum of its symptoms, nor of its chemical or microbic reactions, but is a morbid state in a living patient, and it is in dealing with his patient, when fully cognisant of all that can be learnt of him, that the physician proves his power.

The highest form of the experimental method in Medicine is that which Surgery offers. As by swift changes Surgery has grown safer and still more safe, until at last it can be claimed that a further increase of safety for the patient can only depend upon an earlier access of the surgeon to him, the therapeutic side of our craft has not remained the only one. Surgery is now a strong arm of research and has accomplished much in many directions. In the last half-century the operation theatre has proved to be a most procreant laboratory. Our knowledge of all abdominal diseases has been so greatly and so quickly changed by operative research that a complete revolution in thought and in action has resulted. I can think of few researches which compare either in scientific or in therapeutic importance with those which have been made by the surgeon during the last fifty years. Certainly no more fruitful combination of the inductive method with the method of apposite and felicitous experiment has ever been known. We look forward now to a time of help from our laboratory associates which may bring us to an understanding of the causes of those local diseases whose consequences alone are eradicated or rendered less injurious by the operations we perform. The first step at least has already been won by the surgeon in demonstrating the interrelation of various morbid states, but the task remains to be carried on, and perhaps solved, by the method of the laboratory along lines which our clinical experience will indicate as necessary. Experimental methods may offer us the proof of a truth which clinical observation has already confidently recognised. Every arctic explorer, for example, knew of the necessity for certain ingredients in the dietary of his shipmates. Gowland Hopkins has given the reason of the ancient experience in terms of vitamins. On a large scale, among our troops in Mesopotamia, the application of this new knowledge received the clearest illustrations. Among the Indian troops an absence of "C" vitamin involved 20,000 men in an attack of scurvy; and among the British troops an absence of "B" vitamin caused a heavy incidence of beriberi. Had such occurrences taken place at the time of the South African War, an explanation, true in essentials, would no doubt have been forthcoming; but there would have been no approach to the precise and accurate and demonstrable explanation which the work of Gowland Hopkins now allows us confidently to offer. It may be that we expect too much at first from laboratory methods. One of the new weapons put by them into our hands is that of vaccine therapy. No one can deny the occasional value, and at certain times the incomparable value, of this procedure; nor can any deny the grave disappointments which have so frequently attended its adoption. The hypothesis upon which it is based is probably very incomplete and many new aspects of a great truth remain to be discovered. But, so far as local infections are concerned, our trust is still in operative treatment. The great triumph of vaccine therapy is in prophylaxis, which is difficult to measure in the individual case but easy to recognise in the mass. The complete record of the incidence of enteric fever in our own army, and in other armies in the last war, is evidence enough to convince the most sceptical.

At this moment there are laboratories all over the world engaged in cancer research. The quest is for the cause of cancer. We do not know whether a micro-örganism is sometimes, or never, or always the agent; whether a habit of body, or a congenital disposition, or a mode of life, contributes something to a larger causative influence. We do know that repeated minor insults to certain surfaces will produce a local response which, though not at first cancerous, makes haste to become so. If the cause of cancer is discovered we may learn to prevent cancer, or even be brought to realise that there is a method of cure which directly depends upon our knowledge of the cause. But let us never forget that we already know how to eradicate cancer from almost all the parts of the body in which it commonly occurs. Nothing is more certain in clinical experience than this: that cancer, whatever its occult nature may be, is in truth a local disease in the first instance; that it remains a local disease for periods which are sometimes short and sometimes very long, and that if then treated by operative methods, upon a plan conformable to modern notions, the disease is completely and permanently eradicated. The unending difficulty is to obtain access to the disease while it is still in the local stage. This, I venture to assert, imposes a new and larger duty upon the profession of Medicine—the duty to enlighten the public as to the early symptoms and signs, and to make it a matter of common knowledge that cancer is not, as everyone supposes, a disease from whose immediate or recurrent ravages there is no escape. We must broadcast the truth that, with few exceptions, an early operation for any cancerous disease is attended by the slightest risk, if indeed by any, and may confidently be expected to confer a permanent immunity from a return of the same disease. We do not know the cause, or causes, of cancer, but we do certainly know how to "cure" it, if only early opportunities are vouchsafed to us.

We most gratefully pay our tribute to Koch for his discovery of the tubercle bacillus. A knowledge of the existence of this organism, of its properties, of its causative influence in those "strumous" diseases whose exact nature was formerly unsuspected, is all to the good. But our therapeutic power has not been increased by our recognition of the existence of the bacillus. No chemical attack made upon the bacillus while in the living body can destroy it, and the extent to which, if at all, we can augment the defensive powers of the body by any vaccine therapy is quite uncertain. The measures we adopt in the treatment both of the medical and of the surgical forms of tuberculosis are really independent of our acquaintance with the properties of the bacillus; they are measures which clinical experience little by little has indicated and improved. In other diseases, as in tetanus and in diphtheria, our therapeutic efficiency depends almost entirely upon the knowledge of their specific bacterial origin. All the efforts of all of us in league together are therefore necessary in our struggle against every disease, and we must surely base our strength not less upon the methods of the father of the inductive sciences, Hippocrates, than upon Galen, the father of the experimental method.

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THE RELATIONSHIP OF RADIOLOGY AND SURGERY*

It must, I feel sure, be difficult for the younger generation of physicians and surgeons fully to realise the magnitude and the high value of the help that is now given to us by the work of the radiologist. Each generation inherits the work of its forerunners, and it requires an effort of imagination denied to most of us to picture the conditions of earlier days in which many of our present resources were still undeveloped. None of us, I think, quite appreciated the difficulties against which Lister had to contend in his early investigations until we were suddenly confronted with the nauseating and startling horrors of those heavily infected wounds with which we had to deal in the first few months of the great war. And the lessons we learnt then increased, if that were possible, both the admiration we all felt for the toilsome and honest work that Lister did, and our gratitude for the imperishable heritage which he bequeathed to us.

So it is also with radiology. It requires a considerable effort of memory, and some skill in reconstruction, to recall for ourselves the days when only the note given by a sound in the bladder as it impinged against a stone made certain the diagnosis of calculus. The word "certain" is too emphatic; for I can still vividly remember Marcus Beck telling us in his ward at University College Hospital of the errors in diagnosis that might then arise when the sound struck the spine of the ischium and produced a muffled note, or when a trinket on the watch chain of the surgeon tinkled at the moment the instrument was rotated in the bladder. Nor can I easily forget the infrequency with which an exploratory operation upon the kidney revealed the presence of the stone whose existence had been confidently predicted, nor the uncertainty and ill success which attended the search for a calculus in the ureter. The change from those days, with the hesitation, the guess-work, the bitter and humiliating disappointments, to these days of confidence and precision is almost immeasurable; and it is to the devoted and skilful workers in the fields of radiology that we are grateful for the transformation. It is natural and fitting that this day should be held as a day of remembrance for one of the greatest of the pioneers—Mackenzie Davidson. It will, perhaps, be appropriate if, in my rôle of a physician doomed to the practice of surgery, I endeavour to show, more particularly in connection with abdominal diseases, in what degree we have taken advantage of the new methods of diagnosis and of treatment which radiology has afforded us.

Diagnosis

Let me begin with the pharynx and œsophagus, though an evening's entertainment might not unprofitably be devoted to a discussion of the value of radiology in connection with the disorders, real or assumed, of the hidden portions of the teeth. It is true that diverticula of the pharynx were known long before the days of radiology. The first case was related in a letter from Mr. Ludlow, a surgeon of Bristol, to Dr. William Hunter of Glasgow, and is recorded in *Medical Observations and Enquiries*[1] of 1767. Ludlow speaks of a "preternatural bag" in the pharynx. The figures he gives are exquisite, and are unsurpassed for beauty and accuracy by any later illustrations. The specimen is in the Hunterian Museum at Glasgow to this day, and a recent drawing of it shows that it has changed very little in the last one hundred and fifty years.

The diagnosis of the condition in its fully developed state is not difficult. Radiology not only makes the diagnosis quite certain, but it gives a quality of precision that could not otherwise be obtained. We learn not only that the preternatural bag is there, but we know where it lies, how large it is, what attachments it has made, and all details that may be helpful to us at the time of operation.

Of diverticula of the œsophagus we knew nothing before the days of *x*-ray examinations except that which was learnt from *postmortem* examinations. These little wayside tracks are not often of clinical importance. When filled with food they press upon and distort the tube from which they spring, and cause an uneasy suspicion as to the presence of cancer, a suspicion that only time allays.

Œsophagus.

Of the condition known as cardiospasm we could, of course, know nothing accurately apart from the examination made by the radiologist. It is true that our museums contain many specimens of "idiopathic dilatation of the œsophagus," but the recognition of this deformity, the knowledge of the size, position, capacity, and occasions of emptying the pouch, the extent of the tube involved, and the position of the barrier, we learn only from the screen examinations. In the first case I saw after I had just learnt of the disease from Professor Mikulicz we had "washed the stomach out" many times, and removed from it large quantities of fermenting, offensive, and disintegrating food that had been long retained. When this little operation was repeated under the control of the x-ray we saw with amazement that the tube never entered the stomach, but lay coiled within the immense cavity formed by dilatation of the esophagus. We failed completely to pass any bougie into the stomach though careful and repeated attempts were made. A duck-shot tied on to the end of a long piece of silk at last was seen on the screen to enter the stomach and to pass along the intestine until it emerged at the anus. When all the length of silk was entangled in the intestines and formed there a fixed point, I threaded bougies over the strand hanging from the mouth and so guided them safely into the stomach. The obstruction was fully dilated, and the patient taught to pass bougies. When she was expert the silk was cut at the mouth and at the anus, and a week later the whole length of it was vomited. Since those early days I have treated many patients, and though examinations with the œsophagoscope are made, we still rely chiefly upon the radiologist for the information which directs our treatment. There is no doubt that most of these cases were formerly regarded as malignant, and gastrostomy was done for them. A patient in the Leeds Infirmary was seen by me twenty years after this operation had been performed by Mr. Ward, on the supposition that a carcinomatous growth obstructed the gullet. An x-ray examination showed the typical appearance of this disease.

The differentiation between "cardiospasm" and carcinoma now presents no difficulties, for the appearance of the œsophagus filled with an opaque medium is quite characteristic in both diseases. The large size of the œsophagus, its tolerance to food, the vigour of the peristaltic waves, which do not move the meal forward, the rounded, blunt end of the shadow which reaches to the diaphragm in cases of cardiospasm, contrast as sharply as possible with the slight distension of the esophagus, the intolerance to food, the incompleteness of the obstruction, and the narrow tapering of a shadow which is very rarely exactly on a level with the diaphragm, in cases of carcinoma.

Diaphragmatic hernia is a rare disease. Its recognition without the aid of radiology is excessively difficult or perhaps impossible. It so happens that I have had 4 cases in my charge—2 in the time before we used the *x*-rays and 2 since. Neither of the first 2 was recognised until the abdomen was opened, and both were discovered with a shock of surprise. The latter two had been recognised by the radiologist; one was on the left side, as most cases are; in the other the sac lay in the right side of the chest, and its contents—the stomach and the transverse colon—were easily recognised in the radiograph. I know of only 1 other similar case; it was operated upon by Sir Hugh Rigby.

Ulcer of the Stomach

In connection with gastric disease it is hardly too much to say that we owe almost everything to the radiologist. As we look back upon the history of gastric ulcer in respect of its symptoms, its diagnosis, and its treatment, we must now realise that before the radiologist came to the rescue there was little that could meet with our confident acceptance. I do not doubt that more errors have been made in the diagnosis of gastric ulcer than of any other disorder. Its symptoms are mimicked with so much accuracy by other diseases that it is not only the unwary who are deceived. The radiologist has put all this right, or nearly right, and has, I think, explained the cause of the so remarkable plagiarism by those other diseases which arouse gastric symptoms. It is, however, not only diagnosis that has been at fault, but the treatment that has been based upon it. How can we explain the devotion of physicians to the alkali treatment of gastric ulcer except on the assumption that the diagnoses upon which such methods first were founded were erroneous? For in about 80 per cent. of the proved cases of gastric ulcer the free hydrochloric acid content of the gastric juice is either normal or below normal or absent. And the surgeon is far from guiltless in the matter. He has too often been content to accept the diagnosis of "gastric ulcer," and, basing his treatment upon it, has performed gastro-enterostomy. which, unhappily, he has been led to believe is a panacea for all gastric disorders and a swift and certain cure for gastric ulcer. The accuracy with which a competent radiologist, given time, can make a diagnosis of chronic gastric ulcer which the operation will confirm, must in time lead to the abolition of these foolish practices by us all; and radiology will prove the most effective remedial agency for the loose talk and incoherent thought which distinguish so much of the literature and practice of days that are not yet past. May I urge once again that, until our knowledge is clarified and our practice established in reason, no diagnosis of gastric ulcer based upon clinical evidence alone be accepted as a warrant for treatment? A chronic gastric ulcer, unlike the emperor's new clothes, is a real thing. It is to be seen, and during operation can be handled, exposed, and demonstrated. If it is there at all, it is there for all to see. No gifts of vision are conferred upon the surgeon which are denied to the onlooker. If the surgeon says an ulcer is there, any competent witness can test the truth of his statement. And the accuracy of the radiologist in the diagnosis of this disease nearly approaches that of the surgeon who inspects and handles the stomach. The radiological diagnosis of gastric ulcer is not, however, constant in its accuracy. The greatest difficulties are met with when the ulcers are small, lie on the lesser curvature, are close to the cardiac orifice, and veer towards the posterior surface. The sheltered position of the part of the stomach which harbours them, the overlying liver, the barrier made by the wall of the thorax, and the impossibility of direct palpation of the stomach here, all are hindrances to the exact methods applicable to the exposed gastric area. All these difficulties are, however, in some degree surmounted if the dark meal is carefully watched as it enters the stomach, if the patient is placed in the Trendelenburg position, and if convergence of the folds of the gastric mucosa to a definite point is observed. There are times when an ulcer may be demonstrated if the filled stomach is pressed down from the epigastrium by a pad of wool, more and more increased in size; the stomach is thus rotated a little on its long axis, and an oblique or transverse view may then disclose an ulcer crater. The occasions of error in diagnosis are, however, so few that radiology remains easily supreme above all other methods in the accuracy of the diagnosis made with its help.

If the diagnosis of gastric ulcer is made by no matter whom, let us agree that it is not to be acted upon by the therapeutist with drugs or weapons unless the radiologist confirms it. It is admittedly true that this expert may sometimes fail to see an ulcer which is undoubtedly present, especially if he is hurried in his examination by the importunity of the physician or the impatience of the sufferer himself. But, given a good chance, his errors will be few, far fewer than those of any other investigator. And it must be conceded by us all that the value of any treatment—dietetic, medicinal, or operative—cannot be gauged unless we know the precise condition for which that treatment has been prescribed. At present, with the best will in the world, I am unable to learn anything which satisfies my intelligence as to the worth of any of the methods of medical treatment in cases of gastric ulcer. And I am not often without the opportunity of seeing lamentable examples of mischievous and meddlesome surgery practised upon those who were unmistakably arraigned as the victims of gastric ulcer in need of surgery. In all parts of the world operations are being practised by those whose natural gifts may perhaps warrant their ambitions to be surgeons, but whose apprenticeship to the most superb and most difficult of all the arts has not been served with that devotion and surrender which alone equip a man for this office. I am amazed at the ready acceptance by patients of the eager ministrations of incompetent operators, when adequate skill and experience are at their command. The frequency of secondary operations when the first, being needless, yet produced effects that must now be undone, and of skimpy operations for carcinoma, say of the breast, which invite a quick new growth of cancer cells distributed over the exiguous wound, are a reproach to surgical work.

I think that the radiologist has done much to explain the reasons for the so frequent inaccuracy of the diagnosis of gastric ulcer. When we inquire as to the conditions which cause the symptoms of this disease, we who deal with the living are quick to admit that it is not only the presence of an open ulcer, with its crater of varying depths, that is the responsible and immediate agent; for it is a very common experience to find an open ulcer when the symptoms are in temporary abeyance, the patient enjoying one of the "intervals" so characteristic of the disease. I believe that a state of active increase of the ulcer is essential to the production of symptoms: when activity dies down and the ulcer makes an endeavour to heal all is quiet. The enlarging ulcer sets up a spasm in the stomach—the "incisura" of the radiologist. The "notch" on the greater curvature, opposite, or about exactly opposite, the "niche" on the lesser curvature is sometimes so deep that it seems to cleave the stomach into two parts. Watched attentively for as long a period as is safe, and examined from time to time, it appears unchanged. The conclusion at first was irresistible that an hour-glass stomach existed. Yet when an operation was performed the spasm had vanished. The cause of the symptoms of an ulcer seems clearly to lie in this spasm. The pain is doubtless due, in part, to the distension of the zone lying on the cardiac side of this spasm.

The occurrence of spasm is not, however, restricted to cases of gastric ulcer. There is a reflex spasm which, in many of its qualities, so closely resembles the direct spasm that in haste a false conclusion as to the presence of an ulcer may be drawn. The reflex spasm, even when it is as deep as the direct spasm, is rarely so constant, or so immobile; it is apt to be shallow, fugitive, changing from one part of the stomach to another, and at each part persuading one that here, at least, is an ulcer. Such a spasm may be excited by conditions so diverse as cholecystitis, tuberculous disease of the intestine or cæcum, chronic appendicitis, and certain conditions of the central nervous system. No gastric ulcer, of course, exists without infection; infection may be present, too, in the pyloric part of the stomach when its primary source lies elsewhere. It is long since I described the "pyloric blush" of chronic appendicitis, and Braithwaite's work[2] in this connection is full of interest. If, therefore, these two conditions, spasm and infection, are present both in the true and in the apparent disease of the stomach, there is little wonder that the symptoms aroused by them should often lead even the alert and earnest diagnostician astray. The only competent authority to distinguish before operation between the spurious and the true is the radiologist, and, as I have before ventured to claim, his work has pride of place among the methods of diagnosis in all forms of gastric ulcer.

It is not only in the diagnosis of gastric ulcer that our resources have been so greatly augmented, but in the recognition of its occasional complications. Many years ago I laboured hard to discover, and in several papers elaborately described, the various signs which permitted the hopeful recognition of an hour-glass stomach. The signs were many, the labour to elicit them protracted, the judgment difficult and not free from faults. Now the radiologist will tell us every detail that is relevant; not only is the diagnosis indisputable, but the site of the constriction, the size of the two complements of the stomach, the speed with which one or other will empty, the degree of adhesion if any—all, and even more than these, are stated with unequivocal accuracy.

Cancer of the Stomach

We shall all, I do not doubt, be prepared to concede our inability to diagnose cases of carcinoma of the stomach in an early stage. Of gastric carcinoma there are, speaking roughly, two great groups. In the one the patient has suffered for years at intervals from mild or severe forms of gastric discomfort. Finally, one attack, at first very like all the others, proves rebellious. Relief is not given by the remedies which hitherto have proved so easily successful. At the operation an ulcer, transformed in part to carcinoma, is found. In the second group are the cases I refer to as "the bolt from the blue type." The patient has perhaps been notorious for vigorous gastric health: he scorns the suggestion that he may perhaps have been a little dyspeptic. His denial of former ill-health is disdainful to the point of arrogance. Suddenly he becomes ill, and perhaps the illness is ushered in by hæmatemesis of great severity. He loses zest for many things—food, his former activities of work or play; he loses weight, becomes anæmic, and when he is examined a lump is felt in the epigastrium. It is a melancholy but indisputable truth that, despite the activities of a small body of surgeons in this country, carcinoma of the stomach is almost always an incurable and fatal disorder. I should doubt if there are a hundred patients in the whole country who are alive and well five years after operation for the second type of carcinoma to which I have just referred. The reason for this lamentable condition of affairs lies chiefly in our incapacity, by any clinical means, to make a diagnosis in the early stage. As a profession we are not, however, blameless. We have not the courage of our experience. For when a patient over forty-five begins with these insidious failures of health our tendency is to procrastinate, when we should not delay a moment. Lives are lost in part through ignorance, in part through timidity. The radiologist is now our strength. He is able, given time, to make a diagnosis of filling defects, recognising interrupted waves of motion, of a break in peristalsis on the affected curvature, whilst the movement on the normal curvature is unchecked, of deflections of the current of the opaque meal, long before we could be in the least degree confident, by any other means at our command, of the presence of a growth. To ensure a success in treatment greater than that most meagre form we now command, two changes are essential: all patients about whom we have a doubt should be sent forthwith to the radiologist, and the x-ray examination should not be hurried.

Diverticula

What should we know of diverticula of the duodenum but for the radiologist? I have carefully searched the literature of this subject, and though the condition was first described in 1710 by Chomel,[3] no case had been diagnosed during the lifetime of a patient before 1912. Yet J. T. Case,[4] in a study of 6,847 consecutive patients upon whom a radiological examination of the stomach and duodenum was made, found no fewer than 85 cases of diverticulosis. Not many of the patients who possess these little wayside tracks from the duodenum suffer from them; their removal is therefore rarely necessary. But regard should be paid to them in all operations in which a diagnosis of duodenal ulcer, or of cholelithiasis, is not supported by the conditions disclosed at an operation, for the retention of foodstuffs in these cavities, or its fermentation, may cause symptoms which are apt to be ascribed to other lesions, and when these are not found on inspection the operation may, in ignorance of this condition, be abandoned as a failure.

Of diverticula of the jejunum occurring during life nothing could be known apart from their demonstration by x-ray examination. The cases are few in number, and the little pockets do not often cause much harm. This is all to the good; for when present they are apt to affect so great a length of intestines as to make removal of the affected segment a matter of difficulty, or even impossible. The best example that has fallen within my knowledge occurred in the practice of my colleague, Mr. Braithwaite, the radiological examination and the diagnosis being made by Dr. Rowden.

Colon

The subject of radiology in relation to diseases of the colon has so recently been discussed in London that I need say little concerning it to-day. When I operated upon the first case recognised as diverticulitis in this country on April 2, 1906, so slight was our knowledge of the disease that a diagnosis during the life of the patient had never been made. Many of the specimens on our museum shelves bearing the label "carcinoma" were examples of the massive inflammatory thickening round these little crypts, and the fact that the majority of the fistulous tracks from the colon to the bladder were not due to carcinoma was generally unrecognized. The diagnosis of diverticulosis is now made with complete confidence by the radiologist, and by comparison of one radiograph with another, taken some months later, we are able to judge the progress of the disease, and to come to a decision as to whether operative treatment is likely to be necessary.

I have a number of patients suffering from this disease who are kept in good health, and are sheltered from the attentions of the surgeon, by medical treatment. This ensures a daily emptying of the intestine, and includes an orgy of aperients on the Saturday afternoons and Sundays which are given over, religiously, to the observance of the ritual of free and frequent evacuation. I find that operative treatment in the chronic form of this disease is rarely necessary.

The diagnosis of carcinoma of the large intestine may present such difficulties to the radiologist that great care is needed to avoid error. The opaque meal and the opaque enema both have their uses, but I find far greater help from the latter. Owing to the loading of the colon, and the tenacity with which fœcal masses will adhere to the mucous membrane, some days may have to be spent in the administration of aperients, and in lavage of the colon before it is empty. A small, hard, adherent mass of fæcal material will show the same filling defect as a growth, and imprisoned gas will prevent the entry of the opaque material. Spasm of the colon, especially in heavy smokers, may suggest an organic stricture, and the overlapping of one part of the bowel by another may cause a deepened shadow or prevent a free entry of the barium mixture. I have been misled both by negative and by positive diagnosis made by the radiologist, but I have been far more often aided than hindered, especially if a day-to-day examination of the fæces for blood, when the diet is free from hæmoglobin, has been made. By collating these two methods of examination, radiological and hæmatological, with the clinical history we are able to recognise malignant disease of the colon before a tumour can be felt, and before obstruction has developed; and, having regard to the fact that the colon lends itself to removal better than most parts of the body, and that recurrence after early operation is rare, this a great achievement.

Gall-bladder

The recognition of diseases of the gall-bladder is now receiving help from the radiologist. In making a diagnosis we are all accustomed to speak of cholelithiasis—to say that a patient is suffering from "gall-stones." But I believe that we shall be able before very long to look upon gall-stones in much the same way as we now regard hemorrhage from a duodenal ulcer, or its perforation—that is, as a quite unnecessary complication. Gall-stones are the expression of tedious events in a terminal stage. Despite my friend Rovsing of Copenhagen, I have unchanged belief in the view that gall-stones are the consequence of infections which reach the gall-bladder from one or more of several sources. Our business is to search out the inaugural symptoms, the symptoms of infection of the gall-bladder, and to use all the means that the radiologist—employing, too, the method of Graham—can bring to our aid. I look forward hopefully, and not without confidence, to the day when we shall regard cholelithiasis as a preventable disorder. It is true that the clinical diagnosis nowadays is not often at fault; we are able to predict the presence and the position of stones in the gall-bladder or the ducts with a large measure of certainty. Even the precalculous stage of this disorder is becoming day by day easier to discover. Though we can clearly see the gall-stones on the radiograph in about one-third of the total number of cases in which they are shown by operation to be present, they are not often seen where they are not confidently expected. The indirect signs of cholecystitis are of more interest than the shadow of stones, for they display the changes which the disease has brought about in neighbouring organs by the presence of an enlarged gall-bladder, or by the traction exerted by a shrunken gall-bladder which has become adherent to them. The advantages of Graham's method would seem to lie chiefly in the opportunities afforded for research into the physiological activities of the gall-bladder, and into the functions of the liver. We do not yet know in what circumstances and at what rate the gall-bladder fills and empties, and we have still much to learn of the secretory activities of the liver. The absence of any shadow after the Graham injection has been made, is indicative of a closure of the cystic duct by a stone or by a stricture, or of the failure of the gall-bladder to concentrate the bile. But a mistake in the recognition of the two organic conditions is almost unknown. The danger attaching to Graham's present method appears to be very slight, and doubtless, with enlarging experience, will disappear. The salt used by Graham is useless as a test for hepatic efficiency, owing to the fact that its colour is destroyed in serum.

The *x*-ray examination of the gall-bladder after its removal, and of the stones which it contained, shows that the smaller stones almost always contain nothing but cholesterol. A very few have a nucleus, or an ingredient, of calcium. It is only after a certain size has been reached, and a chronic irritation of the gall-bladder has been incessantly at work, that calcium in little spots or as a thin film is laid down on the surface of the stone.

The conclusion I draw from the radiological work done in connection with cholelithiasis is that it enables a diagnosis to be made which would, in rare instances, perhaps be in doubt; that it discovers the existence of associated lesions in neighbouring viscera; and chiefly that it is a powerful instrument of research in enabling us to discover the composition of stones, and therefore to learn something of the processes at work in their formation, and by

Graham's method to add something to our very imperfect knowledge of the functions of the gall-bladder and of the liver. In other conditions the help of the radiologist to the clinician is still more invaluable. In diseases of the kidney and ureter, in the discovery of stone within the bladder or of diverticula protruding from it, we are even in danger of allowing our clinical diagnosis to ignore the history, and to base itself confidently upon radiology alone. No doubt others are as weak as I am. When a patient complains of pain in the loins I am tempted to ask first what the radiologist says, and to accept his word as law. Indeed, he is so constantly right when the clinician alone would be so often in doubt that here too he is both guide and governor. The use of the "bonnet," which so greatly helped us in the removal of projectiles during the war, may well be remembered when the kidney, delivered from the wound, is being searched for stones. And here, too, research work upon the normal and pathological anatomy of the kidney and ureter, after opaque injections have been made, and upon the chemical constitution of stones, has added notably to our knowledge.

One of the most delightful uses to which radiology has been put is that which Sicard introduced for the localisation and discovery of tumours of the spinal cord. My knowledge of this comes from Mr. Percy Sargent. I confess that I felt a thrill of pleasure when I first learnt of this neat and ingenious method.

Limitations

One very important point remains. All the methods, other than the application of our own senses directly to the patient which we so willingly use in the practice of surgery, are after all ancillary. They strengthen our clinical armoury by adding weapons of varied and sometimes, as in the case of radiology, of immense value. But they all supplement our clinical resources; they do not, and cannot, supplant them. In regard to gastric ulcer I cheerfully acknowledge that the radiologist is, on the whole, a more competent and a more accurate diagnostician than I am. He has pride of place. But I find an occasional case when, being confident of the existence of an ulcer, I learn that the radiologist doubts, or even denies, the diagnosis which nevertheless an operation confirms. I accept with gratitude a positive diagnosis made by the radiologist; but if my clinical sense urges me, after the rebuff of a negative report from the *x*-ray department, to hold to my diagnosis, I may find my tenacity rewarded. In a long series of cases the radiologist will, however, prove to be right more often than the clinician.

When the clinical diagnosis of an ulcer, or of a diseased gall-bladder, or of an enteric growth, is not confirmed by the *x*-ray report, what is to be done? The whole case must once again be reviewed. In cases of gastric ulcer I hesitate to go contrary to the report of the radiologist, but sometimes I am driven by my own confidence to do so. In cases of duodenal ulcer I prefer my own opinion, linked with that of the chemist, to that of the radiologist. If he gives a negative opinion and I am persuaded of the accuracy of my own, I am prepared to act upon it, and I find I am more often right than he is. In gall-bladder disease the clinician, if unsupported by the radiologist, should be prepared to act alone. I could quote many instances where patients, including medical men, have heard the diagnosis of cholecystitis from the clinician, and on learning that it lacks confirmation by the radiologist have been lulled into contentment and a dangerous inactivity, only to be roused by a very formidable catastrophe. If the careful clinician has made a diagnosis of cholecystitis or cholelithiasis, a report from the radiologist that gives it no countenance should be disregarded. And so it is with suspected malignant conditions of the large intestine. Though a radiological examination often affords the greatest help when confirmed with the clinical history, and with the daily search for occult blood, the earliest and the most certain diagnosis of these diseases, after all, is made when the barrier of the abdominal wall is lifted away.

Therapy

The treatment of carcinoma wherever it occurs is a disheartening business. The recognition by patients and by medical men of the earlier conditions of malignant disease, even in parts that can be seen or are easily accessible to examination, is unhappily infrequent. It seems almost incredible that patients should allow ulceration of the tongue, for example, to progress to a stage in which remedies are almost hopeless. The diagnosis presents no difficulties, and inspection of the tongue in a mirror ought surely to awaken anxiety. And at every meal time discomforts must be felt or limitations of diet be necessary. When a lump appears in the breast of a woman her natural timidity makes her, perhaps, unwilling to submit herself to examination. And when the tumour is plainly felt by a medical man no little time is lost in discussions as to its nature. Nothing but the microscope can settle the diagnosis in a difficult case; to wait for the appearance of those signs which convince the surgeon that the tumour is malignant is to give time for the disease to be disseminated. A review of many cases over a period of twenty years results in this interesting law: "In tumours of the breasts of women over forty years of age, not less than 80 per cent. are malignant, no matter what the physical signs of the tumour may be." Diagnosis, therefore, is largely a matter of the age of the patient. It is a far more reliable guide than any other. Many cases follow upon chronic inflammatory lesions—in the mouth, in the breast, in the stomach, upon the skin, in the colon. Cancer, therefore, is often a preventable disorder. And in its early stages in most organs of the body it is a curable disorder. To the surgeon two facts about cancer appear indisputable: that it comes as a result of long-continued trivial irritation, and that it begins as a purely local disorder, and can in that stage be wholly eradicated.

It is pitiable to find so large a number of cases which are inoperable, or which, having been treated by operation, suffer recurrence. To deal with these cases many remedies have been sought. Radium has proved its value in some of them, and the application of *x*-rays was soon included among our methods. Twenty years ago or more I sent all my breast cases, and all cases in which glands had been removed from the neck after excision of the tongue, to the radiologist. Of the effects produced by the methods of radiology in such cases it was difficult to judge. If the patient remained free from recurrence, one was unable justly to apportion credit between the radiologist and the surgeon; if the disease returned, both had proved powerless. I came tardily and reluctantly to the conclusion then that, on the whole, more harm than good was done, and I abandoned the method entirely.

When the deep *x*-ray methods were introduced I felt renewed hope, and with the most skilful and enthusiastic co-operation of Dr. Cooper I have submitted a very large number of patients to his treatment. An exposure to the deep *x*-ray may be made (*a*) before operation; (*b*) during operation; (*c*) after operation; (*d*) when operation is impossible.

(*a*) *Before Operation*

In my own practice this is not often adopted in cases of cancer, for I feel that if a growth is to be removed it may be possible to eradicate it to-day and impossible to-morrow, and I never waste one single day. But in cases of carcinoma of the breast, when the activity of the growth and the rate of its extension seem almost inflammatory, it may be worth while to apply the rays, not so much to the growth as to the area around it, in the hope that the cells in lymphatic vessels, which might be set free to implant themselves upon the surface of a wound, may be destroyed.

In cases of carcinoma of the rectum, or of the uterus, with much induration and thickening around the tumour, and when adhesions appear to be present, the rays may cause a change so great as to make one doubt the truth of the earlier observations. The growth shrinks, loses its induration and fixity, and from appearing irremovable seems now to offer no difficulty. In one case in which, in an enfeebled old woman, much distressed by a teasing diarrhœa, I had performed colotomy, the growth entirely disappeared. I had removed a gland at the time of operation, and the diagnosis of carcinoma was not in doubt. No doubt the growth will reappear, but its complete removal is an evidence of the great effect which the rays are able to produce. In all cases of splenic enlargement one or more exposures to *x*-rays are given. The reduction in the bulk of the spleen is almost incredible: from filling the whole abdomen the organ shrinks until a lump the size of a golf ball is felt below the costal margin. Then the spleen may be removed with a safety and with such ease as could not be claimed for any operation upon it in its original state.

(*b*) *During Operation*

In cases of Crile's operation upon the glands of the neck, and in cases of carcinoma of the breast, I think we might more often expose the entire area of operation to the rays before we close the wound. I have done this in a number of cases, and though it is impossible accurately to gauge its value, on theoretical grounds it certainly appears a very desirable procedure. I have long felt disheartened by our inability to perform more often than we do radical operations for carcinoma of the stomach. I therefore determined to enlist the help of the radiologist. The application of *x*-rays to the surface of the abdomen, though it may rarely do good in these cases, does sometimes appear to do harm. I tried a new method. While the abdomen was opened and the stomach exposed I moved the patient to the *x*-ray room, and there, bringing the growth as far as possible into a widely opened wound covered by a single layer of macintosh gauze, I applied the lamp directly to the stomach for a period of forty minutes. The abdomen was closed. Seven weeks later in one case, nine weeks later in another, I reopened the abdomen and found the growths so changed and shrunken that I was able to remove them, with all their attached glands. Two operations of gastrectomy in this way were performed in 1923, and to-day both patients are alive and well. One has gained 33 pounds in weight, another 9 pounds. In both two transfusions of blood were given—one at the time of the x-ray exposure and one before the removal of the stomach was undertaken. There is perhaps a future for this new method, the surgery of access, in cases of carcinoma whether the deep x-ray or radium is to be applied.

(c) *After Operation*

As soon as the wound is healed after removal of the breast, a course of treatment by the radiologist is now advised in all cases. The hope we entertain is that any cancer cells in the neighbourhood of the wound will be killed, and that recurrence may be so prevented. Of the prophylactic value of the rays we cannot speak with any certainty. A local recurrence after an operation for mammary carcinoma is, in any event, so rare that a very long series of cases would be necessary to establish the value of postoperative radiation. But, again, on theoretical grounds the treatment appears so rational that I should not feel content to omit it.

It is perhaps desirable to urge once again the necessity for an x-ray examination of the chest and neck before any operation for carcinoma of the breast is undertaken. The search for metastatic deposits in outlying regions should invariably be made before removal of the primary source is undertaken. When recrudescence of the growth has taken place in the neighbourhood of the wound, or when glands appear in the neck, radiation will often produce the most remarkable results. I have known multiple nodules scattered widely over the chest-wall to disappear completely, and to remain absent until the patient's death in consequence of visceral deposits; and glands, grossly enlarged and causing pain in the neck and head, are diminished in size or caused to vanish, and the lancinating pains soon disappear.

(*d*) *Inoperable Cases*

A visit to the radiological department engaged in the treatment of these cases is a depressing experience. Cases for which the surgeon can do nothing, and cases for which he has done all he can, are sent to this last resort. All the surgical outcasts find refuge here. If radiology could do nothing for them no blame could attach to it, for more unpromising derelict material it would be impossible to find. Yet something is wrought upon these cases that at times approaches the miraculous. Growths shrink and wither away, and foul and extensive ulcers make vigorous attempts to heal, and hæmorrhage from excavating caverns ceases entirely. Growths of the thyroid seem to melt away, and growth of the parotid, hard, fixed, and painful, may disappear very quickly. But the return is not long delayed. The most dramatic result I have ever seen was in connection with a carcinoma of the thyroid as large as the patient's head, which disappeared almost entirely within a month, only to return with almost equal haste and quickly to prove fatal. There are, of course, many disappointments, and at present one is not able confidently to reckon upon any improvement in the individual case; but the fight for each one is always worth while.

The effects produced upon the patient are sometimes apt to be serious unless great care is taken. The red cells are so diminished in number that great enfeeblement results. I have many times given one or two transfusions of blood in patients who have to submit to *x*-ray treatment, and hypodermic injections of iron are administered regularly, and most patients are given artificial sunlight baths.

The gifts of radiology to medicine and to surgery have been most lavishly bestowed. When we consider that this science is a newcomer into the fields of diagnosis, of therapy, and of research, the results obtained in so short a time are surely matters for which humanity at large may feel profoundly thankful. If I may for one moment arrogate to myself a greater authority and a wider responsibility, I should like to offer to you, gentlemen, in the name of all your colleagues, my respectful homage for the immense benefit you and your forerunners have already conferred upon mankind, and to express my confident prediction and my warmest hopes for the continued and beneficent progress of the science which you so worthily represent.

*The Mackenzie Davidson Memorial Lecture delivered before the International Congress of Radiology, July 3, 1925. Reprinted from the *British Medical Journal*, 1925, ii, 47.

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CANCER AND HOW TO FIGHT IT*

If the law of averages holds good, one hundred people in this room will die of cancer. Statistics, I was once courageous enough to claim, will prove anything, even the truth. The truth is that in this country one person in every seven, over the age of thirty, dies of cancer, that 50,000 people die yearly in England and Wales, and that, according to Hoffman, 500,000 lives are annually lost in the civilised countries of the world from this disease. But the law of averages appears to be changing against us, for there is little doubt that cancer is definitely on the increase, especially in certain organs. Cancer is an ancient and a heartless foe. Examples of its lethal power are found in bones taken from the tombs near the pyramids of Egypt, dating from 3,500 years before Christ. It was known and described over twenty centuries ago by Hippocrates, the Father of Medicine, and it has never since ceased for one single day to take toll of precious lives.

A survey of the progress of medicine during this century shows that we are, little by little, but very surely, obtaining control over certain diseases which were formerly the plagues of mankind. In comparison with them cancer not only shows no decrease; it is actually gaining ground. Cancer is now the most dreaded, the most inexorable, the most menacing of all the physical infirmities of our race. It is the "Captain of the men of death." Let us give figures:

In the last twenty years—
- The general death rate has fallen 32 per cent.
- The infant death rate has fallen 45 per cent.
- The tuberculosis death rate has fallen 38 per cent.
- The cancer death rate has increased 20 per cent.

In the last seventy years the mortality from cancer has increased fivefold.

Attempts have been made to explain this increase in the death rate of cancer:

(*a*) By consideration of the fact that, the average expectation of life having increased, a larger number of people live to the cancer age, which is the period of life beyond forty years. To some extent this is true, but the average duration of life is longer chiefly because of the lower infant mortality. Dr. Leonard Hill says:

> "The expectation of life has gone up for infancy but not for the period of late middle age. There is no problem of what we are to do with our grandfathers, they are living scarcely any longer than they did fifty years ago."

(*b*) By ascribing it to increased accuracy of diagnosis. In this, too, there is truth. But if we pay regard to those cases in which diagnosis can never have been difficult, because the disease was near the surface and easily seen or felt, we find this argument is not sustained. For example, in cancer of the tongue there has been an increase of 39 per cent., and in cancer of the breast of 28 per cent., in the last twenty years. But it must also be remembered that some few diseases called cancerous in other days are now known to be simple. This is true of diseases of the stomach and of the large intestine.

This increased mortality from cancer, chiefly in the alimentary canal, has occurred despite the fact that more people than ever are being cured of cancer. It surprises many to hear that cancer can be cured; that the patient can be relieved for ever from his disease. But it is true. To-day operations of wide extent and of low mortality are more often followed by a permanent freedom from recurrence than they were twenty years ago. The operations practised to-day are more frequent, of greater extent, of greater safety, and attended by a larger measure of permanent relief from the disease than was the case twenty years ago. We are apt to hear of the failures of surgery as well as of its successes. Montaigne thought the doctor among the most fortunate of beings, because the sun shone upon his successes, while his failures were buried in the tomb. But this is not altogether true. We hear of deaths from operations, of recurrence from cancer after its removal; we hear little, even from the rescued, of their freedom from this disease. Cancer is rarely mentioned by those who have suffered from it; they appear to regard it as a sort of moral blemish, as something that is better not discussed, as something equivalent to idiocy or epilepsy in the family.

If it is true, as it is indubitably true, that permanent relief from cancer is being secured by our present methods in large numbers of cases, the question naturally arises as to why this is not more often possible. We are all a little to blame. Medical men are sometimes, though I am glad to think not very often, inclined to watch the earlier phases of this disease, especially when attacking internal organs, until it is certain that the condition is malignant. The certainty of diagnosis is often the certainty of death. If we wait until we know, we wait until we cannot cure. We must "look and see, know and act," and not "wait and see."

And the public is in part to blame; for among them there is great ignorance of the possibilities and the achievements of surgery, and ignorance is the parent of unbelief. What is the attitude of a patient who discovers a lump on the body, say a tumour in the breast? She says, "There is something wrong here; it may be cancer; if it is cancer I must undergo an operation; if I do I may die; if I survive, the disease may come back; if it returns I must submit once again to operation with all its risks; even then the disease may recur. It is a hopeless and depressing prospect; I had better not mention the fact of the lump." And so time passes: the tumour grows and grows through every moment of every hour of every day, and at last the patient submits to a rescue operation, which the surgeon is reluctantly compelled to perform, knowing that he must do his best in adverse circumstances when precious time has been wasted, when the chances now are all against him. Unhappily, it is not very infrequent for the delay to be encouraged by the wasteful trial of other methods. The "cancer curer" is still a curse in the land, and the most pathetic credulity as to his claims is shown by people who should know better.

Cancer never yet was cured by the quack, but infinite harm has come to patients from the delay which foolish, impotent, and pernicious practices have involved—a delay which has allowed a small local disease to increase and to be strewn about the body. The desire for methods other than those which authority advises is as old as the days of Naaman, captain of the hosts of the King of Syria. When Elisha advised him to wash seven times in Jordan and so be cleansed of his leprosy, his wounded chauvinism made him cry out, "Are not Abana and Pharpar, rivers of Damascus, better than all the waters of Israel?" The sufferers from cancer are still beguiled by ignorant and pretentious quacks, and encouraged in their beliefs by irresponsible busybodies distinguished only by their complete ignorance of scientific method and their complete absence of scientific temper. Their statements are disputable in fact, doubtful in logic, and tend to betray the people whose lives must pay the penalty of their folly.

Who are the victims of cancer? A man's life has three stages: a stage of growth, of preparation for manhood and all its manifold activities; a stage of accomplishment, when all that he has learnt is applied to the purposes of his daily life; a stage of decline, when his vigour slowly wanes, his work is fulfilled. Cancer seizes a man, as a rule, in the later half of his second period, when his trained mind or hand is at its best; when his judgment has ripened; when his worth to his family and to the community is at its highest; when the service he can offer to the world is of greatest value; when knowledge grows to wisdom. This is the time for a man to live; the time to die is when work is done, when joy in labour has gone, when faculties are dimmed and enthusiasms quenched, when a man is no longer an asset to the world and has perhaps become an encumbrance even to himself. Cancer seizes a man when he is most needed by his family, who still ask a father's counsel and help, and is needed by the community for the service he can then best render.

Is it not, therefore, time for us to bestir ourselves, and to seek new sources of strength to fight this eager and relentless foe? To overcome an adversary we must make a study of his methods, inquire as to his origin, his designs, his power. If we have already encountered him, we must discover both the circumstances in which we have been able to win a victory against him and the conditions under which we have suffered defeat.

What, then, do we know of cancer?

Cases of cancer may conveniently and for purposes of brief description be divided into two groups: First, those in which the growth is lying either on or near the surface of the body, or is attacking organs, or parts of organs, which can with no great difficulty or danger be removed. Secondly, those in which the growth is relatively inaccessible, lies out of sight, cannot be felt, and only reveals its presence by symptoms, or after examination by x-rays. In these cases an operation may be difficult, impracticable, or even impossible.

How, then, can we expect to conquer or control this disease? It is obvious that two methods of attack must be followed.

In the first place we must so instruct the public, and educate ourselves that those cases of cancer in which complete eradication of the disease is surgically possible shall be recognized and treated at the earliest moment. The operations now practised are reaching their limits, not only in extent and in the safety with which they can be performed by expert surgeons, but also in respect of the pain or discomfort they inflict. We cannot reasonably hope for any considerable change in any of these directions if the material upon which we work remains unchanged. We do, however, know that operations performed in the earliest stages of the disease are safer than those in the latest stages, when the patient's health is seriously undermined by the disease, which may have spread insidiously beyond the farthest reach of the surgeon. We can make surgery safe, and even more successful, not so much by strengthening the arm of the surgeon as by enlisting the help of the patient; by encouraging him with the knowledge that accessible growths are capable of complete removal, with small risk, and with permanent freedom from recurrence, if only they can be reached in time.

And, in the second place, we must carry out all manner of research to disclose the secrets, the most baffling and elusive secrets, of the cause and the prevention of cancer, so that inaccessible cancer shall also be treated with success, or even prevented. We may even dare to hope that we are not far distant from the day when these mysteries will at last be revealed, when what is perhaps the heaviest burden ever laid upon mankind shall at last be lifted.

With regard to the education of the public there are certain disadvantages, some fanciful, some real. It is said that if we "talk cancer" we shall make people "think cancer." We hope that is true. We do not wish the public to "forget cancer." For cancer is an unforgiving enemy, and once he has settled upon his victim, he never for one single moment ceases to grow, and the sooner you confront your foe the better for you and the worse for him.

It is said that we shall increase fear. That I firmly believe is impossible. The fear of cancer is so great in the minds of many people, if not in all, that it is impossible to add to it. Cancer is the King of Terrors. If we can help the public to learn that it is not cancer, but ignorance with regard to cancer, that is in part responsible for their horror of it; and if we can assure them that cancer under certain conditions and when attacking certain organs is capable of complete removal with permanent freedom from a return of the disease, shall we not be able to diminish or even to banish fear? There is no evidence to show that cancer is bred by fear; that those who are fearful of its onset are especially liable to become its victims. Ignorance here, as elsewhere, is a part of fear; but fear does not contribute to the incidence of cancer. Fear should be the fear of delay, the fear lest a simple disease may become cancerous; the fear lest a local, and therefore curable, cancer should increase until it becomes generalised and incurable. Knowledge will bring freedom from fear. May I quote with warm approval a sentence from Mr. Hastings Gilford's book *Tumours and Cancers* (p. 601)?

> "A common impression is that it is not good for the public to concern itself about cancer. It is suggested that in this matter ignorance is better than knowledge—that it is better for people to remain in the dark than to let in the light. As a matter of fact we all know, when we think about it, that this attitude must be wrong. Cancer in reality is bad enough, but this bogie-hole way of treating the subject causes it to assume forms in the imagination more terrifying than they actually are."

Those of us who have been responsible for the Yorkshire Branch of the British Empire Cancer Campaign have realised the necessity of the education of the public. If surgery has almost reached the limit of its powers in removing disease, and if it is true that the earlier the disease the more effective is the operation in eradicating it, it is obvious that the recognition of an early stage of the disease cannot be made, and action thereon taken, until two consecutive events are secured—the awakening in the patient's mind of a need to consult the doctor, and action by the doctor, who, in turn, seeks aid from the surgeon. Unless, therefore, a patient knows something of the antecedent conditions of cancer, of its early manifestations, of the importance of early treatment, how is he to realise that a medical man should be consulted without the delay of one single day? Surgeons can hardly extend the limits of their work; but they may truthfully claim that if they are given a chance their present methods are capable, and that no other methods are capable, of effecting a permanent eradication of the growth in every case of accessible cancer. In Yorkshire I have "the happiness to command a band of brothers." The Medical and Scientific Committee of the Yorkshire Council of the British Empire Cancer Campaign, over which I preside, has appointed a Propaganda Subcommittee, under the chairmanship of Dr. Hillman. This subcommittee will endeavour to instruct the public in such matters as it is essential for them to know if they are to help us, and will teach them to realise that the only hope of amelioration or of cure in cases of accessible cancer rests upon early diagnosis and skilled surgical treatment.

Dr. Hillman writes to me:

"The Committee is to issue leaflets. Its members and others will give addresses to various local bodies, and will organise 'Exhibitions,' where microscope slides, graphic statistical charts, skiagrams, leaflets, striking 'posters,' and ingeniously described models will be shown. These Exhibitions are to be placed in charge of a qualified woman doctor who will give information to visitors and will answer any questions they may put to her. An hour each day will be devoted to 'women only,' and instruction is to be given in matters concerning tumours of the breast, irregular discharges, and so forth.

"Each 'Exhibition' is to be held in a vacant shop, centrally situated, and will last for one week; the arrangements for it are made in co-operation with local committees and with local medical officers of health. The demonstrations are purely educational and are not intended to raise funds.

"The subcommittee is now engaged upon a programme for taking these exhibitions to the principal towns and villages in the county. If they prove successful, as they have already proved to be in two towns, it is intended to take a travelling exhibition on a motor lorry to the scattered villages.

"By these means it is intended to take a message of Hope to all who care to listen, and the subcommittee believes that a material lessening in the number of 'inoperable' cases will follow. It is a striking fact that at the first two Health Exhibitions held in Hull and Rotherham no less than 73,000 persons attended.

"The outstanding impression conveyed to the organisers was the keen and earnest desire for correct information manifested by those attending.

"Each Exhibition is to be opened by the local mayor, or other prominent citizen, and its existence is made known by leaflets (distributed by boy scouts, clinic officials, and others), by illustrated slides at cinemas, and by pulpit references at all the places of worship.

"Interest has been stimulated by the demonstration of various electrical and other appliances, generously loaned by a surgical instrument firm, but all advice as to treatment has been studiously avoided. The only advice offered has been: 'Don't delay; don't conceal; be medically examined if you have the least suspicion that anything is wrong with you.' "

What are the lessons we can teach the public in connection with this disease? The following are some of the truths it is important for them to know:

1. *Cancer a Local Disease at First*

Cancer is always at first a local disease. This is an extremely important truth. For many years (and even to-day in the popular mind at least) the belief that cancer is a "blood disease" having local outbreaks is firmly held. In typhoid fever the general disease has its local manifestations. It is often supposed that the events in cancer are similar, that the blood is contaminated, and that the local evidence of this is the nodule or the ulcer, recognised as cancerous. All knowledge we possess refutes this view. Cancer begins locally; it remains local for periods that vary in length according to circumstances; it may even prove fatal while still local, and therefore, if accessible, still removable. There is no single exception to the truth that cancer in its beginning is a local disease.

2. *Diseased rather than Healthy Organs Attacked*

Cancer chooses to attack a diseased rather than a healthy organ. It has been said that cancer never attacks a healthy organ, but that is to set the standard of health rather high. It is, however, quite certain that any organ, or the skin, when affected by some chronic disorder, is more apt to be attacked by cancer. This involves the necessity for us all, patients and doctors alike, to pay attention to health and to do all we can to keep fit. The majority of people, it may be said, commit suicide. If we consider the effect of alcohol, syphilis, tubercle; of the conditions which are set going by the rush for wealth, with all its attendant sacrifices of caution and prudence with regard to health from day to day, the statement, though shocking, appears to be true. St. Paul advises us to "keep innocence." We wish he had said "keep health," for sin is not seldom a synonym for disease.

3. *Cancer Influenced by Antecedent Conditions*

The occurrence of cancer is influenced by antecedent conditions. The corollary to this is that cancer in certain instances may be regarded as a preventable disease. Sir Jonathan Hutchinson, many years ago, described what he called "precancerous conditions"—conditions which, though not yet cancerous, would become cancerous, or tend to become cancerous, if neglected. These are best seen upon the tongue. Cancer almost never develops upon a healthy tongue. The tongue affected is one which has suffered for many months or years from chronic superficial inflammation, due to syphilis, or smoking, or both; from cracks or fissures, or ulcers; or from denudation of its papillæ by one cause or another. Chronic irritation is a definite precursor of cancer. This is seen especially upon exposed surfaces. Mule-spinner's cancer appears upon the lower parts of the abdominal wall in consequence of the protracted irritation of lubricating oil, and of repeated small injuries by the loom. Cancer was common in former days in chimney-sweeps; and "kangri cancer" in those living on the hills in Kashmir is caused by the wearing of a basket of burning fuel beneath the clothes. In those who work in aniline dyes cancer of the bladder appears far more frequently than in others.

4. *Cancer Uninfluenced by Certain Factors*

The occurrence of cancer, so far as we know, is uninfluenced by certain factors, sometimes regarded as "causes."

(*a*) There does not appear to be any hereditary predisposition to cancer. The fact that one person in seven over the age of thirty dies from cancer must in this connection be remembered. It implies that within the limits of slight variation from this normal the incidence in any family may appear to be unduly heavy. Probably few families of ordinary size escape cancer in three consecutive generations. Striking instances of the frequency of cancer in one or two generations of a family, and equally remarkable examples of its absence, come under observation from time to time. The work of Miss Maud Slye upon mice appears to show that a tendency to the development of cancer can be engendered by special breeding; but I cannot recognise any similar liability in man. The example of Napoleon and his relatives is often quoted in support of the contention that this disease "runs in families." But it is, we think, now generally admitted by those most competent to form an opinion, after an examination of his abdominal viscera, that Napoleon did not die of cancer.

(*b*) Cancer, so far as we know, is not caused by any special food or foods, nor by any absence of special foods. It is true that excessive indulgence in food when little or no exercise is taken will steadily and insidiously depreciate the general health; and that in such circumstances of lessened resistance a person may more easily fall a victim to cancer as to other diseases. Various articles of diet have been impunged—tomatoes, fresh meat, salt, and many others; but there is no evidence that would satisfy a scientific mind that these or any other articles of diet, in excess or in abstinence, play any specific part in causing this disease. The question of the effect of diet in cases of cancer has been much discussed; and a rather embittered controversy between the layman and a few medical stragglers on the one side, and the majority of the profession on the other, has not languished in recent years. It is true that a general supervision of a man's dietary when he is in health, or in illness, will often produce a sense of well-being and bring back a degree of vigour long forgotten. But, so far as we know, no change in the natural history of a malignant growth has ever been observed by competent authorities to result from such dietetic control in an indisputable case of carcinoma.

The Memorandum on Cancer issued by the Ministry of Health states (p. 3) that "it cannot be asserted with scientific authority that the use of any particular article of food increases the liability to cancer or prevents it from appearing." There appears to be no truth in the claim that restriction in diet or temporary starvation effects any real change in the disease; nor has any evidence that could satisfy a critically scientific judgment been adduced to show that the cure of cancer, or its demonstrable subsidence or relief, is in the smallest degree dependent upon special systems of dietary. The Yorkshire Council of the British Empire Cancer Campaign are financing a new research upon this subject of diet in relation to cancer. Professor Mellanby of Sheffield has, with the consent of the University, undertaken this work, which could not be in more competent hands.

(*c*) There is at present no sufficient proof that "cancer houses" or "cancer districts" exist, though here again striking examples of individual exceptions to this statement may be observed. Further inquiry may well be conducted to resolve this question, and we are proposing to undertake a new survey of this matter in Yorkshire.

5. *Cancer neither Infectious nor Contagious*

The disease is neither infectious nor contagious. Very few surgeons have ever seen any case in which transmission of the disease by contact could conceivably explain the development or localisation of the disease.

6. *Spread by Direct Extension*

The disease spreads from the spot originally affected by direct extension; by the invasion of lymphatic vessels, which then convey cancer cells to neighbouring glands and thence to distant parts; and rarely by invasion of the blood-vessels and the transmission of cancer cells in the blood-stream. The reverse procedure never occurs. That is to say, the disease never begins as a generalised systemic disease—as a "blood disease" having, in a later stage, a local manifestation.

7. *Pain Rare in the Early Stages*

In the early stages cancer rarely causes pain. This is a truth which it seems very difficult for a patient to realise. One of the commonest incidents of practice is to hear a patient protest that a growth cannot be of a serious nature because no pain results from it. Perhaps few things surprise the surgeon more than the discovery of an advanced state of carcinomatous ulceration of the tongue. It seems impossible that a patient could tolerate the presence in the mouth of so repulsive a condition, one affected by every word of speech, by every movement of mastication and of deglutition; one capable of easy recognition by the patient, who has only to open his mouth in front of a mirror to realise the horror of the growth. Yet pain in the tongue, even when it is chafed and fretted by a jagged tooth, seems absent or inconsiderable; and when pain is present it is the ear, rather than the mouth, of which complaint is made. In tumours of the breast no pain, as a rule, is caused until the skin is involved; the lump is discovered by accident, and little regard is paid to it because it causes no inconvenience or discomfort. The truth that in women over thirty-five years of age a lump in the breast is malignant in 3 cases out of 4 needs all the repetition and emphasis that can be given to it. The silence of some forms of growth in the stomach and the rectum is notorious. In the alimentary canal it is often obstruction rather than discomfort that first attracts attention.

In cases of cancer ill health, anemia, lassitude, distaste for food, and loss of weight are often regarded as the symptoms without which a diagnosis may hardly be made. In the earlier stages they are rarely present and are never conspicuous. The existence of carcinoma is compatible with perfect health, and in a few cases there may even be a gain in weight and a remarkable feeling of vigour and strength. "I never felt better in my life" is a statement often made by an incredulous patient who has just heard that he suffers from cancer. The symptoms now mentioned are significant, but they are apt to indicate a state of the disease which should be anticipated, if possible, by the discovery and eradication of the growth before they have time to appear.

8. *Cancer Curable when Local and Growth Accessible*

While the disease is local and when the growth is accessible cancer is curable. This is a necessary and logical extension of the truth that cancer is invariably local in origin, and that it spreads from the point first attacked. While the disease is local the complete eradication, not only of the parts immediately involved, but of all the adjacent parts which are most likely to be first implicated in its extension, would also cure the disease. It is true that the patient might then live long enough to develop another type of cancer elsewhere; but the instances in which this has occurred are so rare as to be surgical curiosities, and of no importance in stating the truths of a general problem. There are, however, a large number of cases of carcinoma where the growths are not accessible to the surgeon, or lend themselves only to the most dangerous and least successful forms of attack.

The Control and Treatment of Cancer

Our main reliance in the treatment of cases of cancer to-day is upon surgery. If a growth is accessible and local, no other method than that of operation should be considered. The difficulty is to discover whether the disease, at the time the removal of the growth is contemplated, remains localised, or whether it has already extended to the primary glands, or perhaps has even spread beyond them. In many cases it is unhappily impossible to tell. Nothing could more clearly show the advantages of early operation, and the tragedy of neglect, than the statistics collected from the Leeds cases by Miss Gretta Wardle under the auspices of the Leeds Cancer Committee and published by the Ministry of Health. Here are the figures. The report deals with a series of 357 cases operated on in the General Infirmary, and in the Hospital for Women and Children, Leeds, during the two periods 1910 to 1913 and 1919 to 1921. In every case the tumour has been submitted to microscopical examination. The cases have been analysed by Dr. Janet Lane-Claypon and classified on the following basis:

Class I.—Cases in which, so far as could be ascertained, the growth was entirely confined to the breast, the axillary glands not being involved.

Class II.—Cases in which the axillary glands were already invaded, but in which there was no evidence of involvement of any other neighbouring or distant organ or tissue.

Class III.—Cases in which either the adjacent or distant organs or tissues were involved—for example, the pectoral muscles, the skin when ulcerated, the cervical glands, the opposite breast, etc.

Excluding cases unclassified on account of insufficient clinical and pathological data, the following are the results of operation after three, five, and ten years, respectively:

	Percentage alive at		
	Three years.	Five years.	Ten years.
Class I	89.6	85.1	71.4
Class II	36.3	18.5	5.2
Class III	28.0	13.5	5.6

If, however, the cases which died from the operation and those which died from other causes than recurrence of cancer be excluded the after-results are as under:

	Percentage alive at		
	Three years.	Five years.	Ten years.
Class I	94.0	91.3	87.5
Class II	38.1	20.0	5.8
Class III	31.1	15.1	5.5

The results for the complete operation of removal of the breast, pectoral muscles, and axillary contents (Rodman's or Halsted's operation) may be shown thus:

Class I.—Growth still local; 90.1 per cent. *alive* at ten years after operation.

Class II.—Axillary glands involved; 91.3 per cent. *dead* within ten years of operation.

Class III.—More advanced cases; 94.4 per cent. *dead* within ten years of operation.

For cases in Class I the number of survivors is within 14 per cent. of that shown in the general population table. They prove that cancer can be completely eradicated if the local growth is early and widely extirpated. They show that the degree of success depends upon the stage of the disease attacked by the operation. They are eloquent as to the need for haste, and as to the follies of delay.

The methods of surgery, however, are not always available. If the growth is inaccessible, or if a growth at one time accessible has by delay become disseminated, then no operation can eradicate the disease, and recourse must be had to other methods. Of these, by far the most valuable is the therapy of the deep x-rays. From their skilled application the most remarkable results are occasionally observed. The retrogression of the disease, or even its disappearance for two or three years, does not justify the use of the word "cure." Though I have seen the most striking results—results which five years ago could not have been believed possible—I have never seen a patient "cured" by this treatment. The best testimony to the truth of this view of x-ray work is shown by the refusal or reluctance of the skilful radiologist to undertake treatment in any case in which surgical measures are possible. This means that only the cases in which surgery can do nothing are undertaken by the radiologist; and yet it is in these very advanced and otherwise hopeless cases that results are obtained which show the efficacy of the method.

In certain cases radium has its uses, and very remarkable temporary results are obtained. It is only, however, in cases of rodent ulcer, and by no means always even in them, that permanent freedom from recurrence has been observed. Cases of cancer of the tongue may show great improvement, and healing of a large and chronic ulcer may occur. Of the lead treatment of Blair Bell we cannot speak with certainty. But we know that a devoted and most earnest worker, with a scientific mind, and a scrupulous regard for sincerity and truth, is devoting his great talents, with an almost reckless disregard of his own time and his health, to the pursuit of what he believes to be a serious contribution to this grave problem. We must remember that Bell's only chance of success is with the case in which everyone else has failed; with this category of the outcasts he has certainly done better than any man.

The points upon which we should at this moment concentrate our attention in our fight against cancer are, therefore, two:

1. To make the very utmost of our present methods, which are applicable to all cases of accessible growths.

2. To undertake research so that we may discover the cause or causes of cancer, and so be enabled to do something for the prevention of the disease, or for its cure by methods other than those of surgery.

We do not make the most of our present methods, and, in my judgment, we are not likely to make the most until the public is instructed in some of the matters essential for them to know if they are to seek help in that stage of the disease which is capable of cure. There are many medical men who regard with dismay or disapproval the suggestion that the public should be educated in matters concerning cancer. It is said we shall "frighten them to death." I prefer to think that we are frightening them to life. I do not believe we can increase the dread of cancer. I am sure we may easily diminish it by carefully worded instruction. The problem of cancer is so simple and straightforward that any intelligent person may understand it, and by understanding it learn to dread, not cancer, but neglect of cancer. And we must undertake research. We have learnt more of cancer during this century than in all the centuries that have gone before. It is perhaps hardly too much to say that the conquest of cancer is a question of money. Research, ceaseless research, by trained skilful workers; research of the widest kind into all aspects and relationships of the disease will surely capture the most elusive secret of its causation.

In Yorkshire our appeals to the public for help have resulted in the collection of nearly £130,000 in twelve months. A research institute has been opened, and happily is associated with the University, under the direction of Dr. M. J. Stewart, professor of pathology, and of Dr. Passey, professor of experimental pathology and director of cancer research. All the scientific knowledge of the day is, therefore, accessible to our research workers. During the next decade I should like to see the most active and the most populous department of any research institute devoted to the study of the subject of cancer. Research in connection with other diseases has within the last half-century saved millions of lives, released mankind from terrible sufferings, added immensely to human happiness and comfort, and helped to prolong the span of human life.

Research by Pasteur and Lister made possible the almost incredible advances of modern surgery. Research by Patrick Manson and Ronald Ross has given us the whole secret of malaria, and has shown how this disease, which has slain its millions, may be banished for ever from the earth.

Research has disclosed the mystery of yellow fever, and so made possible the building of the Panama Canal, converting a whole district that was a death-trap into a health resort.

Research has revealed the origin and mode of transmission of plague, the very name of which is still heard with horror. Plague is conveyed by the fleas which infest the rat. And so to-day we realise why in Babylon the snake and in Egypt the cat were sacred, were deified, and were worshipped. They devour rats and mice, and so keep away the plague.

Research has made us familiar with the cause of tuberculosis, and has enabled us to reduce the number of cases, the severity, and the mortality of enteric fever.

Research has done much to inform us of the mysteries of cancer. Dr. Gye, whose authority is indisputable, has said that "during the past twenty-five years, that is to say during the period of experimental research into this disease, there has been greater progress in the study of cancer than in the study of any other single serious malady that attacks human beings." We hope that research may discover the cause or causes of cancer and enable us perhaps even to prevent it, or to rescue its victims by some other method than that of operation. Cancer is the most formidable calamity afflicting mankind to-day. The enemy grows yearly in strength, and though we are defeating him in some of his strongholds, he is gaining on us elsewhere. The time has come for a great national uprising against him. And there are plain evidences that we are in deadly earnest in our efforts to subdue and destroy him.

For many minds, with many thoughts and many aims, are now uniting with a common watchword against a common foe. Victory will not come through the gates of dream. It will be won from a stubborn and relentless enemy by an army of ardent spirits who think no toil too heavy if spent in the service of humanity.

* The Hastings Popular Lecture delivered in the Great Hall of the British Medical Association on January 24, 1927.

THE CONTRIBUTIONS OF LEEDS TO SURGERY*

THE craft of surgery is as old as mankind. The earliest human remains show that the art of the surgeon had been practised upon them. Among the hoary superstitions by which men have always been beguiled, that which is concerned with belief in the "possession" of the human body and mind by demons is perhaps the most interesting. The ancient rites practised for exorcism have survived to the present day. In the *Yorkshire Evening Post* of August of this year an account appeared of the casting out of devils from a young girl in Tuscany. For the relief of this malady of "possession" the aid of the surgeon was not infrequently invoked in prehistoric times. Wherever skulls of the Neolithic period have been discovered, openings made by the trepan have been found in them. The apertures are not due to accidents after death, for the shape of the fragments removed is always similar, the parts of the skull in which they are found are often the same, and the edges of the gap show that the discs of bone must have been removed during life, for healing had clearly taken place. The piece of bone removed in this way was worn as an amulet. It is interesting to learn that the operation of trapanning is still practised in the ancient way, to permit the escape of evil spirits confined within the skull, by the natives of New Ireland to the east of New Guinea. Of no art, then, are there more ancient records than of the art of surgery.

Many of the diseases for which the aid of surgery now is asked are as old as human history. In the bodies of the mummies found in Egypt evidences of gall-stones, of appendicitis, of tuberculous disease of the bones, including the spine, of sarcoma of bone, are plain to be seen.

The science and the art of surgery owe their twin birth to Hippocrates, under the fertile inspiration of the Socratic philosophy. His power of accurate observation, combined with ingenuity and integrity in the exercise of the faculty of reason, have rarely, if ever, been surpassed by any man. So vast was the range of his observation, and so amazingly accurate his comments, that the minds of many generations of his successors were fully occupied in the consideration of the intellectual legacy he bad bequeathed to them.

It was not until centuries later that Galen, a vain, ambitious, garrulous, and rather quarrelsome man, brought experiment to bear upon the problems of physiology and of medicine. As Hippocrates was the parent of inductive reasoning, so was Galen of the deductive method. Galen's experiments were, of course, confined to the bodies of animals, and it was by "analogy" that he applied their results to the bodies of men. Though he was the first of experimenters, he asserted that speculation should lead experience. If his reasoned conclusions were not supported by experiment it was because the experiment was fallacious. Yet no man has dominated the mind of the world for so long a stretch of time as Galen. For 1500 years his authority was unchallenged. Men sought for all truth, and for all experience, not in the study of the living patient, but in the writings of this dead philosopher. The Fathers of the Church have never had their writings more implicitly accepted, their doctrines more loyally observed, and their errors more confidently believed than these Fathers of Medicine, Hippocrates and

Galen. For nearly 1500 years the writers on medicine preserved with reverence the old tradition and the ancient knowledge; they discussed every device, and at interminable length they elaborated the meanings of the old Scriptures; they tortured new meanings out of old phrases; they were diligent in dressing old words anew, and their scholarship was judged by their ingenuity and infinite prolixity in so doing.

From the long slumber of nearly 1500 years medicine was awakened by William Harvey. The influence of great teachers in inspiring great students was never more happily shewn than when the great anatomist, Fabricius, became the lodestone that attracted Harvey to Padua. The discovery of the circulation of the blood, a discovery on the very edge of which so many men had trembled, is the great glory of English medicine. But it was a discovery made possible by the example and the encouragement of a great teacher. Harvey was often wearied and despondent. He found the tasks upon which he laboured so arduous and full of difficulties that he was tempted to think with Fracastorius that the motion of the heart was only to be comprehended by God. The discovery has been claimed for many men and many countries. But a strict examination of the evidence leaves no doubt that Harvey's claim is now beyond dispute. The unhappy Servetus had recognised the existence of the pulmonary circulation, and was in consequence burned as a heretic, with all his works, by Calvin, at Geneva in 1553. To controvert the teaching of Hippocrates and Galen was not error only, it was heresy. It required a rare and reckless courage for Henry of Mondeville to say that "God did not surely exhaust all His own creative power in making Galen."

Harvey, Galileo, Bacon, Gilbert physician to Queen Elizabeth, confirmed in their several ways the value of experiment in research. But the method was to find, as yet, no place in surgery, for the foundations of surgery were not yet laid. No knowledge existed as to the nature of the diseases by which man was so grievously afflicted. The morbid appearances of the organs, the processes by which they were attacked and laid waste, were almost unknown. It is due to Morgagni, and to our own John Hunter, that this defect was made good. The science of pathological anatomy was founded by them, and their investigations were carried so far that, nearly a century and a half later, we may still read their works with advantage.

The first of the surgeons in Leeds was a pupil of John Hunter. William Hey was one of the founders of the Leeds General Infirmary in the year 1767. At the age of fourteen he had been apprenticed to Mr. Dawson, a surgeon of Leeds, much against his own inclination, for he wished to follow the sea. He studied at St. George's Hospital, and so proper was his conduct, so high his intelligence, and so assured his future that a gentleman offered him his daughter in marriage. Hey, it is said, gave "the same prolonged consideration to this suggestion as he was accustomed to give to all matters of importance," and declined the offer. When he returned to Leeds to practise surgery the outlook seemed unpromising. Mr. Lawman, the chief surgeon of Leeds, had only once operated for the stone, and had only once amputated a limb. In the year 1767 Hey performed each of these operations four times. In the years 1800, 1803, 1805, and 1809—the Leeds General Infirmary being, as now and always, in want of funds—he gave anatomical demonstrations upon the bodies of criminals, and handed the funds over to the Infirmary. As we look back and endeavour to measure the value of the work done by the pupils of Hunter, we may safely claim that Hey was not inferior to any of them, not even to Abernethy or to Astley Cooper, the handsomest and most popular surgeon of his time. London was then the metropolis of surgery. Hey was the first to challenge this supremacy.

The eponymous contributions of William Hey to anatomy and to surgery outnumber those of any surgeon. There are two "Hey's amputations," one in the foot and one in the leg; a "Hey's ligament"; "Hey's hernia"; "Hey's internal derangement of the knee"; the "fungus hæmatodes of Hey"; and "Hey's saws" are in use to this day. Hey founded a dynasty of surgeons. His son, William Hey, and his grandsons, William Hey, Samuel Hey, and Edward Atkinson, who served in the Crimea, were all surgeons to the Leeds General Infirmary. His great-grandson, Dr. Wawn of Ilkley, was a student of the school. Hey was a close friend of Priestley, and their amity was undisturbed by their not infrequent theological controversies. Hey died in 1819 of diverticulitis of the colon.

The names of two great surgeons of the days contemporary with the "Heydays" of Leeds surgery have survived. Samuel Smith (1790–1867) was held in most affectionate remembrance by Mr. Teale and Mr. Jessop, who regarded him as the most "common-sense man" they encountered in their younger days. He was surgeon to the Infirmary for forty-five years, in general practice, and he lectured for thirty-five years on midwifery at the hour of 7 A. M. A widow, anxious as to the engagement of her only daughter to a youth with whom she was unacquainted, took counsel with Sam Smith, and confessed her ignorance of the tests to which the youth should be submitted. "Invite him to breakfast," said Sam Smith, "and if he eats a good meal you may safely allow him to marry your daughter." A letter is extant in which he invites a colleague to breakfast at 5.30 A. M. He was a pioneer in the operation of excision of the astragalus, and his portrait in the board room of the Infirmary will keep this claim for ever before our eyes. He seems to have been every man's friend.

Thomas P. Teale (1801–1867) was the son of a successful Leeds practitioner. He was trained at the United Borough Hospitals, and qualified in 1823. He was elected surgeon to the Leeds Dispensary in 1824, and to the Leeds General Infirmary in 1833. He served for thirty-one years. Like William Hey the first, he had lost one eye in childhood. He excelled in the operations for stone, lithotrity as well as lithotomy, and in plastic surgery. He was active in inquiry and research, and he was eager in pursuit of new plans of treatment. He enriched our museum. He was zoölogist as well as geologist, writing lengthy papers on each subject; and salmon fishing was the recreation in which he, like many other members of our staff, excelled. He invented a new method of amputation, which to this day is known as "Teale's amputation," and is practised more often than its merits deserve. The reasons which made it so successful in the old days hold good no longer, and the long anterior flap is wasteful. Teale also wrote a treatise on hernia, a sound text-book much quoted in its day. He was a Fellow of the Royal Society, and one of the founders of the Leeds Philosophical and Literary Society.

Throughout all these centuries, from Hippocrates to

Hunter and to Hey, the lot of the individual patient was, however, not very greatly improved. More, far more, was known of the causes, symptoms, and morbid processes of disease, but in direct consequence of all this little advantage came to the patient. An operation practised for the relief of any disease was attended by a mortality almost prohibitive, and by a delirium of pain that only the stoutest hearts could face unflinchingly. Anæsthesia, whose merciful discovery we owe to Morton, of Boston (October 26, 1846), robbed operations of their most menacing terrors, but many survived the operation only to perish quickly from its effects. And the effects were terrible beyond belief. A visitor to Paris during the Crimean War wrote: "We can recognise at a distance a surgical hospital owing to the stench of the human putridity it contains." Bell of Edinburth spoke of a hospital as a "house of death." The death rate from all surgical conditions was very high: the simplest procedures, carried out with superb craftsmanship, became deadly because of that infection in the wounds which nothing seemed able to prevent or to control. And then Lister came and all was changed.

It is perhaps impossible for the surgeons of to-day to realise the magnitude of the change that has come over surgery because of the work of this one man. Operations which were attended by a prohibitive mortality are now performed without a thought of mischance; and operations then beyond the power of the most reckless to imagine are matters now of everyday routine. Lister made the old operations safe and the new ones possible. And I have made the claim for him which understates the truth, that he has been the means of saving more lives than all the wars of all the ages have sacrificed. Leeds at this moment, too, had its standard-bearer in the new great fight that was to be waged against diseases hitherto unassailable. Thomas Spencer Wells (1818–1897) was a student of the Leeds School of Medicine, acted as an unqualified assistant to a parish surgeon, and attended the lectures of William Hey the second and the elder T. P. Teale. He had been apprenticed to Dr. Michael Thomas Sadler of Barnsley, nephew of the distinguished author of that treatise, *On the Law of Population*, which attracted the attention of Macaulay. After qualifying, Spencer Wells served in the navy until the age of thirty, when he retired and went to London to practise. In the year 1854 he assisted Baker Brown to perform the operation of ovariotomy; both were discouraged by the death of the patient. In January, 1855, Spencer Wells sailed for the Crimea, and there learnt that "a man's abdominal walls might be lacerated by fragments of shell, his intestines protrude for hours till they were covered by dirt, and yet that after careful cleansing of the cavity and accurate closing of the wounds complete recovery was possible."

In 1856 Spencer Wells returned to London, and in December, 1857, attempted his first ovariotomy; the patient died. The second patient, operated upon in February, 1858, happily survived, and so the way was opened for the intrepid advance which Spencer Wells was eager to make. His success was almost incredible, having regard to the fact that his early operations were performed before Lister's work began, and that the opposition of his colleagues was unrelenting. The moral courage required to persist in his efforts may be inferred from the opinion expressed by the most influential medical review of the day, that the operation was one which, "though it may excite the astonishment of the vulgar, calls neither for the knowledge of the anatomist nor the skill of the surgeon," and that "whenever an operation was performed so fearful in its nature, often so immediately fatal in its results, a fundamental principle of medical morality is outraged." Wells, undismayed, pursued his course, telling with perfect frankness the story of his successes and of his failures, and at last led the medical profession to recognise the value of his work. He was the great pioneer in all the stupendous advance that the art of surgery has made in the last fifty years. Ovariotomy being made safe, other abdominal operations were attempted, and error in diagnosis was not without its value. Spencer Wells, in operating upon a case of "ovarian cyst," found that the fluid was free in a peritoneal cavity whose walls were studded with tubercles. And the surgical treatment of tuberculous peritonitis was inaugurated at that moment. In operating in 1887 upon a young girl, jaundiced from her birth, for the removal of a "fibroid tumour of the uterus," the tumour was recognised as an enlarged spleen. With the quality so characteristic of Leeds surgery of meeting a difficult situation with courage and ready resource the spleen was removed. The jaundice soon disappeared, and a new chapter in our knowledge of splenic disease was opened, and for the first time a patient suffering from hæmolytic jaundice was cured.

The minds of men are too often repelled by novelty. It is perhaps not so much the new thing as the newfangled thing which excites opposition. And of opposition Lister received full measure. His theory and his practice alike were new-fangled, and the assaults upon both were vicious and unrelenting. The attitude taken by the surgeons of Leeds is interesting. The older men were sceptical as to the truth of Lister's teaching: the younger discussed it with enthusiasm, tested it, proved it, and applied it. The fierce opponent to it was Thomas Nunneley (1809–1870). After he was qualified, Nunneley went to Paris "to increase his professional knowledge." On his return he applied for the post of house-surgeon at the Leeds General Infirmary and was not elected. He realised at this time that there was an opportunity for the practice of ophthalmic surgery in Leeds, and he applied for, and obtained, the post of surgeon at the Eye Hospital, and for twenty years worked in Leeds with "eminent success." Then, in 1864, he was appointed surgeon to the Leeds General Infirmary. His most important work was *An Essay on Erysipelas*, published in 1831, and again in 1841. In 1869 he delivered the annual address in surgery before the British Medical Association. The address occupies thirteen pages of the *Journal.* It is well written in a vigorous, graceful, if rather ornate, style, but it contains a bitter attack on the methods of Lister. Allusion was made to the practice of his colleagues and their application of the principles of the antiseptic treatment, and Nunneley asserted that "for every successful case that they could shew with it, he could shew as good a one without it." He then went on to say that lately the omission of the treatment, even in large operations, had been more and more frequent, until its use had become the exception instead of the rule—a change which, had "any marked benefit resulted therefrom, most certainly would not have happened." Now this was carefully calculated to wound the members of the staff. For, as Mr. Pridgin Teale always assured me, the Leeds Infirmary was the first hospital in England to put the practice of Lister to the test; and the improved results from it, even in its crudest forms, convinced the staff of the accuracy of the hypothesis upon which it was based. A flat denial of Mr. Nunneley's statement followed. A letter from Mr. Teale to Mr. Lister was published three weeks later in which it was categorically stated that "Mr. Nunneley was in no sense justified in making such a statement; we still use and have as much confidence as ever in antiseptic treatment," and that "any want of success in our practice may fairly be attributed to imperfections in carrying out the rules." Mr. Nunneley, though urged by his friends to retract, made no reply. Nunneley was the author of an operation for cancer of the tongue which bore his name.[1] It was certainly the quickest, neatest, and safest of all the operations practised in that day. My father-in-law, Mr. Jessop, was apprenticed to Mr. Nunneley. I have heard much of those times in many talks. Mr. Nunneley was a man not without ability of the ready-witted kind. It is interesting to remember that he appeared in defence of Palmer, found guilty of poisoning Cook by strychnine in 1856.

His son, John Nunneley, was ophthalmic surgeon to the Leeds General Infirmary, and in his earlier days demonstrator of anatomy at the school. Infinite reiteration was the secret of his success as a teacher. I can still hear him say, "The cribriform fascia, gentlemen, the cribriform fascia is the deep layer, the *deep* layer of the superficial fascia; the deep layer is the cribriform fascia, the deep layer of the superficial fascia." He was a silent, reserved man, and an excellent chief for whom to work. I was his dresser and enjoyed my days with him, and learnt much from him.

Surgery was now equipped for its great adventure. The science of pathological anatomy had established upon the only sure foundation our knowledge concerning the morbid processes responsible for the symptoms of which a patient made complaint, and for the signs which were disclosed when an examination was made. Treatment could, therefore, deal with structural changes which had been carefully studied. Operations were rendered painless by anæsthesia, and safe by the application of the antiseptic method. The advance that surgery has made in its relief of human suffering, and the prolongation of human life, is incomparable. Nothing that has happened in the world since the birth of time has meant so much in matters of human happiness and welfare. What is the part that Leeds has played in all this great revolution? At the time when Lister was introducing his methods Mr. Wheelhouse (1826–1908) and Mr. Teale (1832–1923) were surgeons from 1864 to 1884. Both contributed new thoughts and new methods to surgery. None of us who knew Mr. Wheelhouse are ever likely to forget him. He was the most punctual man alive. Arriving at the Infirmary less than one minute before eight in the morning, he raised his hand to arrest the porter hastening to sound his bell, and admonished him to wait for the town-hall clock. His bell and the hour struck together. His demeanour was of the most solid gravity; his speech slow and of a solemnity that made one listen with awe to the emphatic announcement of the time of day or the state of the weather. I heard him speak also at medical meetings. What he said seemed, as one afterward recalled it, to contain no message of any value, but one almost held one's breath as one listened to its massive and deliberate utterance. I saw him operate on a few occasions only; he moved, as he spoke, with the utmost deliberation and emphasis. On one occasion I helped him in a very minor biblical operation. I gave the baby chloroform and assisted at the same time. The operation was done in the ward, and as he walked away with the same brooding sense of the vast and profound significance of every act, I listened to a minutely detailed account of the difficulties that had been encountered in this very operation; of cases of which the operation, full of hazards, had been abandoned by no less a man than Tom Nunneley, and of the deaths that had followed upon delayed hæmorrhage. By the time we stood upon the doorstep I was the victim of a profound nervous exhaustion, and I felt that the least I could do, in view of the threatening dangers ahead of me, was then and there most solemnly to vow that never would I suffer my own slender skill and my unripe experience to embark upon so menacing an operation as that which I had just witnessed.

Once as I walked past the theatre door with him he asked who was operating. I said "Mr. Teale; and the operation a lithotrity." He stopped at once, and with a gentle push upon my arm he bade me enter the theatre and watch "the most beautiful little hands in England" at work. The description was not, I think, inaccurate. Wheelhouse's originality was shown in his suggestion of a new method for dealing with stricture of the urethra. "Wheelhouse's operation" is known to this day, and if not practised with such frequency as formerly it is because the conditions requiring it are prevented by more careful treatment of the disease in its earliest stages. Mr. Teale and Sir Clifford Allbutt formed the first alliance known to me in this country. They were the pioneers of "team work." Sir Clifford, the most deeply learned physician of this day, master of a style of English which for sheer beauty and majesty is perhaps unmatched by that of any scientific author of our generation; an orator whose speech makes Time seem hasty; a cultured, upright English gentleman, is the pride of the school he served so long and loves so well. Mr. Teale was the authentic product of Winchester and Oxford, and I know nothing better than that. He was the flawless example of intellectual and moral integrity. He was modest, cautious, reserved; free from any jealousies, ready with words of encouragement, and an occasional word of praise. He had not a creative mind, and we owe no large conceptions to him. His advances were slow but well assured, and he had never to turn back. He gave the utmost devotion to any subject which engaged his eager attention, and though conclusions were slow in finding expression, they became articles of steadfast faith with him. He preached a very noble gospel. The estimate which Mr. Wheelhouse made of his technical skill was not over-generous. He had the daintiest hands, the gentlest touch, the most sensitive movements. He was the first to deal with "scrofulous glands." When in London he was a pupil of Sir William Bowman. Up to the the end of his active life in surgery he operated upon ophthalmic cases, and he devised a new method for the extraction of cataract.

He was a pioneer in domestic sanitation, and his book on *Dangers to Health* became a classic. For his work on hygiene he was made F.R.S. I learnt much from Mr. Teale, for whom I had a deep affection. He was a most courtly, truthful, upright gentleman—a man who honoured his calling, and whose noble example is not soon forgotten.

Mr. Jessop (1837–1903) was beyond question the most popular practitioner in Yorkshire for a quarter of a century. His experience was gigantic, in medicine no less than in surgery. He was in general practice during the whole of his period of office as surgeon to the Leeds General Infirmary (1870–90), and his consulting practice was almost as large on the medical as on the surgical side. He was the greatest man I have ever known in our profession, for to his massive qualities of intellect he added a grandeur of character unsurpassed. Though I knew him as well as any man, I never heard a heartless word or an ungenerous estimate pass his lips. But his silence could be full of awe; and when need arose he could denounce with devastating emphasis the acts or the qualities he believed to be evil. In his examination of a case he left nothing undetermined; he was methodical, comprehensive, and deliberate. That completed, he would discuss the diagnosis, or the treatment, with the utmost circumspection; nothing in the history or in the signs had escaped him; there was never a need to look again or to feel again. Every detail was remembered and its value measured. All men considered his judgment as the final one, and popular sentiment was not alone in feeling that if Mr. Jessop had not seen a case there still remained something to be done, and a gleam of hope was still to be found even in the gloomiest outlook. He was indisputably the best and the safest operator on the staff. He had developed a technique which for those days was good. His hands were strong, gentle, yet compelling. He was imperturbable. No crisis—and there were such events in his time—ever disturbed his perfect tranquillity of speech or action. He never knew the name of any assistant or house-surgeon, and addressed everyone as "Mister." This became in time his own title, and as "Mister" he was known to many generations of students and residents, who regarded him with the deepest admiration and respect, and with, perhaps, a shade of fear. He, too, was a pioneer. He recorded the first case of successful extirpation of a growth in the kidney in this country, and the first case in which an operation upon a patient with advanced extra-uterine gestation saved both mother and child. He was vice-president of the Royal College of Surgeons in 1901.

The greater number of the Leeds surgeons have been home-grown products, trained at the Leeds Infirmary; a few have been imported. The greatest of the foreigners was A. F. McGill, a nephew and godson of Sir William Fergusson. He had the widest vision and the clearest intellect of any member of the staff, and his dexterity, on his best days, was unsurpassed. He had his bad days, too, and it did not take long to discover that these were warnings that the diabetes, from which, with other members of his family, he had long suffered, was beginning to murmur the most ominous threats. He will, of course, be for ever remembered as the pioneer in prostatectomy. His first operation was performed in March, 1887. At that time I was his dresser, and by a happy chance was acting as his house-surgeon. A patient with a tumour in the bladder came to his wards, and an operation revealed a projecting mass near the internal meatus of the urethra, which was removed. In those days the house-surgeon cut all sections for his chief. When I examined this tumour I found it was prostatic, and, with a little glee at the chance to score off my dear master, I met him in the entrance hall the next morning. He asked after the patient, and I said he was doing well, and that the "tumour" he had removed was a part of the prostate. "Oh, was it," said McGill at once, "then why don't we always take the prostate out?" At the British Medical Association meeting in Leeds in 1889 he showed a number of patients, old men seated in a row, each holding his prostate in the jar which still contains it to-day. The question of priority in the performance of prostatectomy has raged fiercely, but no serious controversy is possible. McGill's specimens are as he left them, and they show that from nibbling operations he passed to enucleations, until, at the last, the whole prostate, with a part of the prostatic urethra, was removed exactly as it is done to-day. McGill was a pioneer, too, in gall-bladder surgery, but a most untimely and deeply lamented death prevented his marching with Mayo-Robson along this road which has led to such new and fertile fields.

The surgeon who came at the most pregnant moment and made the fullest use of his opportunities was Mayo-Robson. From McGill, whose dresser I was, and from Mayo-Robson, whose house-surgeon I became in October, 1887, I learned the rudiments of all I have ever known of surgery. Mayo-Robson had been a great prize-winner at the medical school, and he regarded me, I think, with favour from the first, because in this direction I had shewn a greed hardly inferior to his own. He was never a resident officer, and on joining the staff, he has since told me, he was "very raw." But he had an unquenchable zeal for work, a most acquisitive and retentive mind, and a skill of hand and of eye that made him then a marksman of almost the very first rank and a fisherman of the greatest repute. Coming into surgery at the birth of a new time, Mayo-Robson used the methods of Lister to explore regions of disease which had never yet suffered deliberate assault during the life of a patient. He carried a stage further the work of Spencer Wells and of Lawson

Tait on pelvic diseases, and, becoming daily more practised in his art, began to explore the upper regions of the abdomen also. After Lawson Tait had inaugurated the surgery of the gall-bladder, the greatest advances made in our knowledge of cholelithiasis and of its treatment were his. His work on diseases of the stomach surpassed that of any other man of his time. He added greatly to our knowledge of diseases of the pancreas. I thought then, and I am certain now, that in his day there was no surgeon in the world safer than he. His mind was original; he was quick-witted to an amazing degree, seeing in new discoveries an immediate application to some problem or another in surgery; he was as dexterous, as gentle, as accurate in every movement as any man I ever saw; he had an earnest and unwearied desire to help his patients to the utmost of his powers. Perhaps he was not altogether free from the faults of the pioneer and enthusiast. He was a little inclined to make little of his mistakes, or to think that another's share in the work had perhaps been a shade less conscientious than his own. The generous word of encouragement, the word we are all of us the better for hearing on due occasion, did not often pass his lips. During the war he gave noble service to his country; his industry, his devotion, and his great surgical experience were most bountifully given to our troops. The high reputation the Leeds School of Medicine already enjoyed was beyond question greatly advanced by the writings and the work of Mayo-Robson.

Edward Ward was an artist among surgeons, and an inspiring teacher, whose influence was most keenly felt by those who thought more of the spirit than of the matter of their daily work. He was a man of very considerable intellectual power. His capacity for rapid assimilation and for retention, in a memory of wide range, of all relevant instances or of the new literature, were remarkable.

His critical faculty was almost too strongly developed. Indeed, he was perhaps as conspicuous an example as one could easily find of an acute refinement of taste checking action. Though his mental powers were far above the ordinary, he made few gifts to contemporary literature. He seemed to fear that something less than a finely-polished perfection should be the result of his labours.

Like Lord Acton, he certainly knew more than many other men, but hesitated to tell what he feared might prove at last to be a half-told tale.

His choice of words betrayed a keen sense of appropriate and beautiful phrasing; exquisite expression seemed to come easily and naturally from him; his letters rang with phrases apt in meaning and delightful in musical utterance.

His operative work shewed the greatest qualities. It was precise, accurate, neat, finished with something akin to the finest artistry. There was nothing hasty or careless or specious; all was exact, truthful, perfectly and exquisitely controlled and daintily completed. His almost morbid fear of self-display might easily have been mistaken for indolence; and this apparent indolence, in part at least, was due to grave ill-health which for many years he bore with heroic fortitude and patience.

But a man's work may be expressed in several ways. Though little remains of what Mr. Ward himself did, much remains of the influence he was able to exert upon others. He inspired many with a desire to do such things as were within their capacity with a sense of artistry, with dainty precision and with perfect accuracy. He has had some disciples, who still most gratefully remember the inspiration and the encouragement his presence or his wise counsel never failed to give them. If they transmit his message in turn to others, something of the faith that was his may prove to be immortal.

War is a great testing time, of nations as of men. The tale of the doings of the men of Leeds during the World War has been fully told by W. H. Scott. All the members of our staff, of course, gave loyal and continuous service. Harry Littlewood (1861–1921), as administrator of our Second Northern General Hospital, proved himself as competent in the direction of the manifold affairs of that office as he had been skilful and sagacious as a surgeon. Of him I recently wrote in the *Yorkshire Post* as follows: The sudden death of Mr. Littlewood will bring a sense of tragic loss to the multitude of his friends in Leeds, and will be acutely felt by all his old colleagues. He was a man of rare distinction in surgery. He was a witness to the truth that for success in surgery qualities of intellect and of heart must be combined with qualities of character no less distinguished.

Mr. Littlewood came to Leeds with a great reputation, earned as a student at University College Hospital, in London, where the highest academic reward had fallen easily to him. He soon shewed, as resident surgical officer at the General Infirmary, that his administrative and technical gifts were of a very high order. Under his leadership, the work of the residents felt the stimulus of a high ideal when they laboured side-by-side with him.

He had more than one rebuff when he started in private practice in Park Square. Both the Infirmary and the Dispensary appointed others to surgical posts for which he applied, and for a time he was not a little dismayed, and almost disheartened. But the death of Mr. McGill created a vacancy on the staff of the Infirmary to which he was appointed, and from that time onward his success in practice, and his advance in surgical knowledge, in experience, and in wisdom, which is greater than both, grew year by year. He was an indefatigable servant of the Infirmary. His work there was punctiliously and worthily performed. As an operator he was safe. The rash adventure was foreign to his nature. He considered all aspects of a difficult case, and was hard to move when once he had reached a decision. He was cautious, but never timid; quick, without haste; full of resource in every emergency. His sagacity was almost faultless. Though his mind moved easily along the old paths, he was always ready to seek the new. He devised fresh methods and new devices some of which have taken their place in contemporary surgical procedure.

His professional attainments, therefore, were of a very high order, but all his friends will agree that they were not the greater part of him. His qualities of character influenced all he did and said, and they played a conspicuous part in the great influence he had upon many generations of students, among whom his popularity was unsurpassed. Sometimes a little blunt and abrupt in speech, he was direct, sincere and honest in action and in thought. He was a man to be trusted, one for whom affection grew steadily. His work at the Infirmary told upon his health. It is no surprise to find that few surgeons in recent times have served all the years of their appointment at the General Infirmary. The strain is too great. Mr. Littlewood's retirement from Leeds was the direct consequence of his zealous, devoted, and unceasing work.

After a year's retirement he was back in Leeds at the second Northern General Hospital, of which he took command when Mr. Dobson fell seriously ill. Of his work during the war the city of Leeds may well be proud. He commanded a fine hospital with great capacity and with great distinction. More than once he feared that he would be compelled to resign, but his sense of duty overcame the urgent need he often felt for complete rest. Like many other good men, he has paid the price of his devotion. We can repay him only by grateful remembrance of a life well spent in the service of his fellow men and, when the great call came, in the service of his country.

I cannot close the list of my distinguished colleagues without a word in reference to Walter Thompson. Of him I wrote on the day of his death as follows:

The death of Mr. Walter Thompson will be felt as a deep personal loss by all his friends, of whom there are many, for he had a genius for friendship. His unfaltering integrity, his tender consideration for the attitude and opinions of others, his sanity of outlook, his grave deliberation of utterance, made all men feel the most complete trust in his judgment and a warm affection for his character.

I met him for the first time on the day I joined the Leeds School of Medicine. He was a few months senior to me as a student, and in my earliest weeks at the school he gave me several demonstrations upon "the part" which then engaged my interests. He always claimed me as his first pupil. Our whole curriculum was passed together, and our final qualifying examinations were happily surmounted in the same week; we were residents together in the Leeds Infirmary for several years, and we lived in the same lodgings as students in Berlin. I had every opportunity of gauging his talents as a surgeon, and of appraising his character. I never knew an honester man. I never heard from him an uncharitable word or unfair comment upon the work or character of anyone in our profession or outside it. Opinions, often slowly and—as it seemed to me—almost painfully formed, he held with stubbornness and a certain grim and unwavering tenacity; but of malice in the formation or expression of those opinions there was never a trace. He was a man to trust without reserve, and to admire without restraint.

As a surgeon he was a fine example of the Leeds school. He was quite undemonstrative, cautious, exact, and safe. There was no display in anything he did. Every movement fulfilled its exact purpose. He shewed the competence and the invaluable precision of the man who, sure of himself, is a master of the medium in which he works. I never saw him hasty or negligent or bewildered by any event, however unforeseen; in any operation, however difficult. In the practice of his art, he found expression for his character. Both were marked by deep sincerity, by a flawless honesty, by modesty, and by reticence. Our profession is honoured and ennobled by the presence of such men within its ranks.

As we look back, then, upon the first century and a half of the work of our forebears in Leeds, we may, in all modesty, claim that their achievements are not inferior to those of the staff of any hospital in this country. In range of vision, in the subtle invention of new methods, in the skilful moulding of new practice, they have played a worthy and, at times, a very distinguished part. It has not been our fortune to own a Lister, a Hunter, or a Victor Horsley; the highest pinnacles of all have as yet been denied to us. But among those who cluster round the greatest heights the figures of more than one of our surgeons may be clearly discerned. We of the present time have come into a great inheritance which is not ours to squander or to dissipate. Earnestly must we strive to add something—something of our own, however humble. Perilous as it may be to say so, I believe that the paths which we now follow have been explored nearly to the end. The methods of surgery can scarcely be made safer than they are to-day. Operations of the utmost severity are performed by the great masters with an absence of risk that leaves little hope of betterment. The chief risk in surgery to-day comes from delay. But though as a measure of therapy the surgical art has now approached perfection, as the handmaid of medicine, as an instrument of scientific research it has still very much to do. Immense though its achievements in this respect have been, we need in these days a broader method. Experimental research, in spite of its occasional fallacies, must march along with us, and the mass of evidence afforded by our surgical work must undergo a wider and closer scrutiny. Clinical and experimental research we needs must have, both extensive and intensive. These are functions of a university, and to our own university we have but now made our plea. When our centenary is celebrated, I pray that the speaker who will then take this place of mine may be able truthfully to claim that, great as were the achievements in the early days of our School of Medicine, they have been far surpassed by the labours of our successors.

* An address delivered at the Coming of Age of the University of Leeds on December 8, 1924. Reprinted from the *British Medical Journal*, January 1925, i, 36.

REFERENCE

[1] *British Medical Journal*, 1866, ii, 493.

LISTER AS A SURGEON*

SELDOM is a great discovery the product of one man's mind. In the work of other men it has ancestors; forerunners possessing one or more attributes whose final and felicitous association within new work constitutes new truth. When that new truth is fully disclosed its relation to many other truths familiar to all for perhaps many years and in many associations, becomes clear. The claim may then arise that those who have revealed isolated and antecedent truths have priority in the final discovery. Such truths are, however, only progenitors, with no claim to be regarded as their own descendant, the new truth itself.

SURGERY A CENTURY AGO

The immortality of Lister, whose centenary we commemorate to-day, is due to discoveries which did for the craft of surgery what John Hunter had done for its science. The oldest human remains bear evidence of surgery. Before Lister came operations had been relatively few, because of their heavy mortality and their almost insupportable burden of terror and of suffering. Every operation risked the life of the patient from one single cause—putrefaction in the wound. So frequent was this that it was always expected, and whenever it appeared no man might foresee or measure its consequences. Evidence of this we find on almost every page of the old text-books and in the biographies of the great surgeons. It is startling to read that when, in the year 1821, Astley Cooper operated upon George IV for a small sebaceous cyst on the head, so tortured was he by anxiety lest erysipelas or pyæmia might develop that he sought to put upon others the responsibility of the operation—on Cline, on Everard Hume, on anybody but himself. He speaks of the operation in terms which to us now appear absurd, fearing that "it might by possibility be followed by fatal consequences." He says, "I saw that the operation, if it were followed by erysipelas, would destroy all my happiness and blast my reputation"; and "I felt giddy at the idea of my fate hanging upon such an event"; and again, "I am certain that if anything happened to the King that at any rate I should leave London and live in retirement." It is hard to believe that a surgeon eminent enough to be chosen for service to the King should be so deeply moved at the prospect of what was to him, as to us, technically the simplest of operations. The exercise of the art of surgery brought terror then where it now brings joy, to surgeon no less than to patient.

The First Steps

Lister's discovery was very gradual. His earliest interests in surgical inquiry were concerned with inflammation, its cause, its nature, and possible methods of controlling it. In this, as in many of his earlier investigations, Hunter was both inspiration and guide. His paper "On the flow of the lacteal fluid in the mesentery of the mouse," published in 1857, but based on researches begun in 1853, is an extension of Hunter's experiments on absorption. His studies on coagulation of the blood began with an investigation on the blood in the veins of sheep's "trotters" obtained from the slaughter-house. By devising neat and critical experiment he was able to carry knowledge of coagulation of the blood far beyond the point which Hunter and Hewson had attained a century before. Yet the methods he employed were clearly modifications of those used by his great forerunner. By such investigations as these Lister was training himself, but his chief interest lay always in the problem of the healing of wounds. When, therefore, he learnt of Pasteur's researches his mind was open to the new truths and expectant of them. Before the British Medical Association in Dublin in 1867 he said:

"In the course of an extended investigation into the nature of inflammation, and the healthy and morbid conditions of the blood in relation to it, I arrived several years ago at the conclusion that the essential cause of suppuration in wounds is decomposition brought about by the atmosphere upon blood or serum retained within them; and, in the case of contused wounds, upon portions of tissue destroyed by the violence of the injury. To prevent the occurrence of suppuration, with all its attendant risks, was an object manifestly desirable, but till lately apparently unattainable, since it seemed hopeless to exclude the oxygen which was universally regarded as the agent by which the putrefaction was effected. But when it had been shewn by the researches of Pasteur that the septic properties of the atmosphere depended not on oxygen or any gaseous constituent, but on minute organisms suspended in it, which owed their energy to their vitality, it occurred to me that decomposition in the injured part might be avoided without excluding the air by applying as a dressing some material capable of destroying the life of the floating particles."

Lister's first step was, therefore, a realisation of the truth that decomposition in wounds depends upon the activity of living micro-organisms; his second, which followed immediately, was based upon the belief that such organisms might be destroyed in the wound, or as they were about to enter the wound; his third and last, which came more slowly, was founded upon the hope that the organisms within the field of operation might be destroyed before they entered the wound.

Around every step of his advance fierce controversy raged. The scepticism and hostility of early contemporaries was stupid, unimaginative, and petty. The history of science is not only the story of new truths and their slow emergence from error, it is a recital of bitter and vexatious opposition from those who should have been the first to acclaim and to welcome the new vision. Only a few weeks ago we learnt once again of the diffidence of Isaac Newton in the publication of discoveries made years before; his reluctance was due in part perhaps to a native modesty and indifference to the applause of others; in part also to the shrinking of a sensitive nature from the acrimony and coarseness of controversy.

The rank hostility of Riolan to Harvey, the disdainful incredulity of Liebig at the discoveries of Pasteur, are in direct intellectual relation to the revolt of Calvin at the discoveries of Servetus, the animosities of the Church which martyred Giordano Bruno, the threat of torture which subdued the aged Galileo, and all that long record of sinister events which proclaims the inveterate hostility of impervious minds to novelty. For such minds novelty is always error, truth is bent through an angle of refraction as it enters them. Lister's answer to indifference, opposition, and denial was unfaltering continuance in inquiry and experiment, and in the demonstration day by day and case by case of changed results.

The Past Renewed in the War

Few if any now living remember the full horror of the old days. But an experience not dissimilar awaited us in the earliest days of the great war. A pestilence of infection to which we were wholly unaccustomed turned our faces toward the early struggles of Lister. On all sides we heard that our inability to check a raging suppuration in a heavily infected wound proclaimed the failure of Lister's methods. So to Lister we turned again, only to realise, much more acutely, how the problems which faced us had been his problems; how our experience, horrible in its new revelation, had in the first years of his practice been his daily experience. Reading Lister's works with clearer perception and new understanding of the difficulties by which he was confronted, our admiration of his patience, insight, and courage glowed into greater reverence than ever before. Lip-service we had long given to the founder of the new era; we were now compelled to realise that Lister is indeed the man who has changed the face of surgery, the one man who has in truth created, if not a new art, at least new and safe, and illimitable opportunities for the practice of the old art.

The first conception in Lister's mind in respect of treatment was that the organisms within the wound, and those entering the wound, might be destroyed by some chemical agent the nature of which was to be determined by a series of experiments. From time to time changes were made as search brought to light some new chemical substance more active in destroying bacteria and less harmful to the living tissues of man. The search is not ended yet. Up to this moment it has engaged the interest of such men as Dakin, Browning, and J. B. Cohen, and no doubt it will long continue. The problem, however, is not merely that of accomplishing highest bacterial destruction with lowest cellular injury: it is rather one of augmenting the natural powers of cells and of serum to subdue and destroy bacteria and their poisons. Lister, I feel confident, realised all this to a greater degree than many of his successors. Godlee, in his Life of Lister, makes this quite clear. Though the earliest efforts were concerned with the abatement of existing decomposition of wound discharges, it was not long before the problem of the prevention of infection became paramount. It is beyond dispute that Lister clearly realised the distinction between the "prophylactic" and the "therapeutic" uses of chemical agents in surgery. We know now that the old quarrel as to the relative merits of the "antiseptic" and the "aseptic" methods was senseless and jejune, for Lister was indubitaly the parent of both—if, indeed, there are really two methods. No surgeon ever practised with success a method in which agents for the destruction of organisms were omitted. Aseptic surgery is the wise practice of antiseptic surgery. There is a difference in detail, not in ideal or in fundamental truth.

We have no need to discuss the relative merits and claims of Pasteur and Lister. It is true that without Pasteur there would have been no Lister at the time when Lister was. Pasteur set out to discover the truth as to spontaneous generation, and by crucial and magisterial experiment settled that problem once for all. While at Lille, in the centre of a district of many distilleries, the problem of fermentation engaged his mind, and the assertion of Liebig, foremost among chemists of his day, that it was "a change in organic fluids and tissues set in motion by the access of oxygen" was shown to be incomplete. The genius of Lister lay in immediate realisation of the fact that the biological truths established by Pasteur might be applied to other circumstances. His mind was prepared for the new vision by his physiological training. I make no attempt to exalt Pasteur by saying that Lister's work was corollary to his, nor to belittle Pasteur by speaking of his ignorance of the full effect of his work. Let the world be thankful for both. We who are within the profession of medicine have once again to learn that progress depends not only upon our own efforts in the discharge of our daily task of healing, but upon an association as intimate as can possibly be with every aspect of biology.

The Antiseptic Theory and its Consequences to Surgery

The consequences of Lister's work are many and far-reaching. The immediate result was, of course, the complete abolition of many of the dangers attaching to the most certain and most dreaded peril of all—infection in the wound extending to other parts, causing severe and protracted suffering, even grave risk to life itself. But when the few operations then practised became safe, it was obvious that other operations might be attempted. The result was that procedures condemned as "murderous," the practice of which should, in the opinion of high authority, lay a man open to a charge of manslaughter, were greatly increased in number as soon as it could truthfully be claimed that the risk of operation was definitely less than the risk of inaction. The most exemplary instances were found in the practice of abdominal surgery. Ovariotomy, condemned by highest authority as homicidal (the governors of King's College Hospital in 1877 had forbidden the staff to undertake it), became so safe in expert hands that neither patients nor surgeon hesitated in the choice of operation.

In all new advances in surgery it is only the patient whose disease has reached a high development threatening disability, suffering, or death, who is submitted to operation; the cases with the greatest risk already attached to them are the first to undergo adventurous treatment. As the safety of surgery is shown in these, similar cases are treated, but in an earlier stage—a stage in which the surgical risks are less, the convalescence quicker, the mortality lower. Ultimately a fatality occurs only in the exceptional case, from causes connected rather with the original disease than with the operation practised. In my days as a resident in hospital ovariotomy was regarded as an operation of utmost gravity, and was performed with much ceremony in private wards and with special nurses. McGill, who led me by the hand along the path of surgery, always had a Turkish bath in the afternoon of the preceding day, and operated at an unusually early hour in the morning. Some mammoth tumours were removed—tumours which, at times, greatly outweighed what was left of the patient; indeed, we removed patient from tumour rather than tumour from patient. From ovariotomy an advance was made to the treatment of other pelvic conditions. Fibroid tumours of the uterus were eventrated and a constricting band of metal applied to the cervical stump, which was brought up into the wound. When for the first time I returned the pedicle to the abdomen after the operation of hysterectomy, our obstetric physician, Dr. Braithwaite, quailed with horror at such temerity. The conquest of other disease of the abdomen was soon inaugurated; the campaign owed almost everything to those who had practised what we now call gynæcology. Spencer Wells removed the enlarged spleen from a patient whose tumour he had believed to be uterine; and a condition of tuberculous ascites, miscalled "ovarian cyst," improved so much after the release of the fluid that similar cases were quickly claimed for surgical treatment.

The whole abdomen soon became the province of the surgeon, whose activities also rapidly extended to the cranial and thoracic cavities, so that at the present day neither technical difficulty nor any danger in the trauma inflicted prevents the surgeon from dealing with almost any lesion, wherever it may lie, or whatever its nature. There is scarcely any organ which cannot be attacked; there is no inherent and inescapable risk in any technical procedures.

An extension of safe operative measures within the cavities, especially within the abdomen, has resulted in a complete revision of our knowledge of the earlier structural changes in many organs attacked by disease, and of the clinical manifestations which those changes produce. Surgery has proved an implement of reaserch; it is indeed the most powerful of all, though this fact is not yet fully realised, nor is adequate use yet made of it. In the mortuary period of pathological knowledge only the most advanced stages of disease, those stages which at last proved fatal, could, as a rule, be examined. The final symptoms of the terminal changes in structure were, not perhaps the only, but they were certainly the chief interest of the clinician; little was known of the dependence of earlier symptoms upon tissue changes. Pathologists and physicians alike were incredulous as to the truth or significance of much of the new knowledge which the surgeon was daily accumulating as the result of his widening observations. Even to-day the physiologist and physician do not appreciate how much is to be learnt at the bedside or in the operation theatre.

As an implement of research, surgery has been generously used by the physiologist in his experiments upon animals. Perhaps the most entrancing exploit of all was that inaugurated in this country by Ferrier and pursued by Macewen, Horsley, Sherrington, and others, by which the functions of the various parts of the nervous system have been elucidated. There is something of enthralling interest in the story of the localisation of function in the cerebral cortex, in the realisation that in the convolutions of the brain exist allotments each with its own highly specialised and exclusive function. The work of the surgeon upon the abdominal viscera, his discoveries concerning, not only changes of structure in various diseases, but also disorders of visceral reflexes, and symptoms associated with these have been not less arduous, nor less interesting, and even more fruitful in the clinical study of diseases, and in the relief of human suffering.

The capacity of the surgeon to enlarge the area of his operations has been used with gratifying success in the treatment of accessible cancer. The lines of extension of this disease have been the subject of inqury by pathological anatomists, who have studied afresh, not only the lymphatic systems of the various organs affected, but also the exact lines along which the cancer cells may drift or grow. The work of Sampson Handley on the breast, and of Ernest Miles on the rectum, are worthy of special commendation. Since we know beyond dispute that cancer is primarily a local disease, we know also that every accessible cancer is curable if operation is practised in the early stages of disease. That is not the least of the debts we owe to Lister. It is his work that has permitted us so to plan our operations that not the growth alone but also all those parts, such as lymphatic glands into which the growth makes haste to extend, can be removed in one mass, and that infection is now the least of our anxieties.

The Future

We may almost claim that the full effect of Lister's work is now accomplished. We know that for all time operations of every kind may be practised without the grave risks that formerly were prohibitive. Lister has done more than even this. The nations of the earth are forever at war; but are there not between them all the bonds that might unite them so strongly that they could not be separated? Perhaps there is no bond between the nations so strong as that which Lister forged. We have seen in London during the last few days a league of all the nations, and I think it possible that because of our love for Lister, and in the common reverent service to humanity which Lister made possible, a way may be found to heal the wounds not only of man but of nations also. If this could be done, we may rightly proclaim ourselves as the heralds of a new day when there shall be no war, and then the Quaker spirit of Lister, which loathed the drums of war, might forever be at peace.

The art of surgery is far in advance of all the sciences upon which its future progress depends. Until they stand abreast, or even advance ahead, the progress of surgery will be slow. The great search for us all must now be for the methods of applying new discoveries in other sciences, physiology, biochemistry, pathology, physics, and the like, to the study of disease.

Many lines close in the dial's centre. From all the vast periphery of our surgical world messages of gratitude and of homage converge upon Lister to-day. Lister made possible the new surgery, beyond all question the most beneficent art mankind has ever practised. So long as there are men to live and suffer, so long will Lister be there to heal them, to hold the gates of life ajar.

To the honoured dead we raise our monuments, some cast in bronze, some graven in stone; some, like that of immortal Hunter, begun in a man's lifetime, the work of his own hands, are enlarged and lovingly enriched through generation after generation by those who labour in the master's cause. On the roll of honour which, in letters of gold, bears the names of the saviours of mankind, no man is more worthy of remembrance than Lister. His living and enduring memorial is a great, and ever greater multitude of men, women, children, of every nation, of every race, of every creed, through his mercy and by the skill of his most gentle hand relieved from infirmity and suffering and sorrow, and made for a time triumphant over death itself.

It is immortal Lister we salute to-day, the supreme benefactor of mankind.

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* Delivered on Wednesday, April 6th, during the London celebration of the Lister Centenary, 1827–1927.

THE APPROACH TO SURGERY*

This is Lister's year. One hundred years ago Lister was born. Fifty years ago this hospital had the courage to invite him to join its staff, and on the day of his inauguration Lister delivered this annual address at the opening of the Winter Session. At the centenary celebrations, held in London in April and in Edinburgh in July, much was said of Lister's work, of the revolution in surgery of which he was the sole and direct cause, and of the unequalled services to mankind which he was privileged to render. Yet there remains, I think, something more to say, and what occasion could be more fitting than this—what platform more appropriate?

The story has often been told, and there is no need to repeat it here, of the horrors and tortures of surgery before the middle of the last century. The craft of the older men was possibly in some respects superior to our own; in swiftness of movement especially they are said to have been almost incredibly expert. If only the cinema had then been able to record an amputation of the thigh performed by Lister, or an excision of the jaw by Ferguson, I think we should all be as much startled at their rapidity, as horrified at the general uncleanness, at the demonstrable absence of any conception of the truths regarding infection upon which all operative methods to-day are founded.

I have always been sceptical as to the technical accomplishments of our forefathers. Mechanical efficiency, even to one who has capable hands, comes only with practice. If, a century ago, all the amputations performed in London had fallen within the practice of one man, he would hardly have had enough technical work to acquire swiftness or precision in every movement. I do not doubt that, judged by modern standards of accuracy, their operations were clumsy, uncouth, brutal. Little wonder is there that surgery was likened to butchery. Lord Thurlow, when the bill to indemnify the Surgeons Company, and to give it greater power over the profession, was under discussion, said, "There's no more science in surgery than in butchery." To which Mr. Gunning answered, "Then, my lord, I heartily pray that your Lordship may break your leg and have only a butcher to set it." This was the same John Gunning who is said to have given that flat contradiction to John Hunter which acted like a sentence of death. Lister himself speaks of "the bloody and butcherly department of our art."

Surgery is in these days both science and art. As science it accomplishes the purposes for which every science exists: to acquire direct knowledge, to accumulate facts, from a multitude of individual examples to raise a broad truth, to weave generalisations, in its highest accomplishment to link cause and effect. We bring to our aid inductive and deductive logic, recalling with pride that both these weapons of the intellect were first brought into use and established by members of our own profession. As science surgery has not only separate existence, but in its wider sense it is related to and dependent upon many other sciences: upon biology, chemistry, physics, physiology, and the like. Discoveries in these sciences not seldom react upon surgery whose progress has in the past often taken impulse from them, whose progress cannot now continue without them. But surgery is not only, as many suppose, an applied science. If we could conceive it bereft of the aid of all other sciences surgery would still remain a science of exact observation, of inductive reasoning, of pursuit and discovery of broad truths, a method of seeking the causes no less than the remedies of many of the diseases which afflict mankind.

As art surgery is incomparable in the beauty of its medium, in the supreme mastery required for its perfect accomplishment, and in the issues of life, suffering, and death which it so powerfully controls.

The methods by which surgery, both as science and art, could be created, directed, and expanded, were fashioned in early days by Hippocrates and Galen, but for more than a thousand years they were discarded. The works of the great masters were erected in the intellectual market places of the world as idols which all men must worship, or pay the price even with their lives. It is lamentable to realise that infinite harm may in the end be wrought by great teachers when their disciples slavishly imitate and perpetuate not the methods by which they won knowledge but their so fallible doctrines.

Men have not been reluctant to pay tribute to Lister for his incomparable services to the world, through the discovery of the principles underlying the modern practice of surgery, but they have been slow to realise that the eternal truths which he expounded are no less applicable in the domain of medicine. Infection plays a part also in the causation of those diseases which remain the province of the physician. First to discover and to propound this truth was William Hunter who, in studying pernicious anæmia in the year 1900, became convinced of its dependence upon oral infection. The connection between these two conditions, between probable cause and tardy effect, seemed so slender, so incredible, that many workers did not even pay the tribute of enquiry. In medicine a new idea rarely obtains a friendly greeting at the moment of birth. We do well to be sceptical, to demand proof upon proof, and to seek evidence in our own experience before accepting a new doctrine. But when scepticism leans to hostility and is nurtured in derision we become worthy of blame. Quick to accuse Lister's contemporaries for their disdain and incredulity of our great master, we in our day are not free from numbing and sterile apathy. Since the year 1900 Hunter has fought with belated success for the recognition of focal sepsis as a cause of far distant and seemingly disconnected disease. To read his several papers to-day is to be convinced not only of the accuracy but of the far-sighted vision of his teaching. "A voice crying in the wilderness," and like that other, we now realise that his, too, was teaching a true gospel. To-day we recognise the grave importance of small and often concealed areas of septic infection, in the tonsil, the pharynx, the nasal sinuses, the prostate, the cervix uteri, the appendix, the uterine appendages, the gall-bladder, and other organs. Hunter's earlier conclusions had reference to the graver forms of anæma, but we now recognise the dependence not only of anæmia but of glandular diseases, of certain obscure fevers, of various forms of "rheumatic" affections, of gastric and intestinal disorders, of severe affections of the kidney, and of many affections of the nervous system, from "neuritis" to functional nervous and mental diseases, of perhaps all forms of cardiac disease that are not congenital, of purpura, and of other diseases upon "focal sepsis." Before Lister, my teachers told me, the surgeon would look with apprehension for a blush round a recent wound; he would lay his fingers upon the sterno-clavicular articulation to discover whether the joint was tender. Pyæmia, which laid waste the joints of the limbs in a riot of rapid disorganisation, was the most dreaded of all the consequences of wound infection. It was not infrequent for the sternoclavicular articulation to be the first of all the joints to be affected. Rheumatoid arthritis is pyæmia moving slowly.

It is not yet realised, I think, that Lister's work has not only revolutionised the scope and practice of surgery, and revealed the clue to the so-long hidden mysteries of many systemic diseases, but that it has also given to the surgeon and to the laboratory worker the strong instrument of research.

So rapid has been the advance of surgery, so exacting the demand made upon those who practice it to train themselves in the manipulative skill necessary for the performance of newly conceived and newly designed operations, that in recent years few surgeons have found it possible to give adequate time to laboratory research. Surgeons have been regarded, and have certainly too narrowly regarded themselves as mere executants. They are in truth experimental biologists, and in the last two generations have carried out valuable researches into the etiology, clinical manifestations, and therapy of disease. Their observations of the structural changes which, in the human body cause the symptoms they sought to relieve, have brought about a complete revision of our knowledge of visceral disease. Their work has been research in its highest form; it has been carried out upon the bodies of men, it has afforded eagerly taken opportunities for observing a host of new facts, it has exercised the faculties of induction and deduction, it has often linked unsuspected causes with remote effect, and this it has done, mindful all the while of the purpose for which it exists, alleviation of suffering or rescue of threatened life.

The story of the conquests of surgery to-day would be received with incredulity by Lister himself. It is not known that the master ever performed an abdominal operation, yet he it was who made all our triumphs possible. Before Lister's day the opportunities for investigating the processes of diseases in the patient's lifetime hardly existed; and the dangers of even the slightest experiment upon animals were so formidable as to be almost prohibitive.

Research in the science of medicine it is clear is of two kinds, direct and analogical. Direct research is carried out by the surgeon as he conducts an operation. Analogical research is conducted upon animals or in the laboratory, and its chief purpose is to test, to illustrate, to interpret, to explain or to expand the lessons learnt by direct research, or to explore the paths suggested by it. The difference between direct and analogical research in surgery is the counterpart of the differences which existed in Galen's day between direct and analogical research in anatomy. Much of Galen's work is based upon observation of the structure of animals; by analogy this knowledge was applied to man. Are not the physiologists to-day perpetrating the very same error as our great forerunner? Are they not neglecting opportunities for direct research, and too implicitly trusting to analogical research? Anatomy as a science applied to man was firmly established by Vesalius. Do we need in physiology to-day a Vesalius to lead us to the true faith? Why when investigations into the normal processes of physiological activity, or into aberrations from the normal, can be conducted upon human beings are so many opportunities neglected? Why are animals selected for the demonstration of certain physiological truths, and why are physiologists content to expound the truths obtained by observation and experiment, when a visit to the wards would enable the teacher to imprint in indelible characters upon the minds of his pupils the truths that can be demonstrated upon the human body? Why are so many anatomists content to teach only on the dead body?

Lister made analogical research safer than ever before, but he was the one and only creator of direct research. His labours freed experiments upon animals from all the risks attaching to infection, and thereby powerfully increased the opportunities of the biologists. The new weapon of direct research upon man during remedial operations was forged by him alone.

The simplicity of analogical research is of immense advantage. It demands ingenuity in devising and high technical skill in executing experiments, and intellectual honesty in observing and recording results. But the whole analysis of the experiment is objective. A plain answer is given to a plain question, and interpretation should offer few difficulties to the trained mind. In direct research, observations and their interpretation present perplexities which appear to be almost beyond the reach of analysis, for subjective sensation and complex emotional states are so apt to confuse the issue. Man being a far more sensitive creature, bountifully endowed with the gift of expression, can tell us more of himself, of his discomforts, pains, and other manifold clinical occurrences than any animal submitted to experiment. And elucidation, not only of facts directly observed but of sensations of all kinds, their chances and changes, as experienced by the patient, is a matter requiring great industry, the skill of an expert cross-examiner, and a high degree of intellectual integrity free from all prejudice, to appraise all matters with accuracy. He who is to carry out direct research should, therefore, first be trained in analogical methods. For research into the conditions and causes of disease in man both methods of intellectual approach must be traversed. We need direct research to give us our first facts; we seek the solution of our difficulties, and an annotation upon our disclosures through analogical research.

As an example, we may take the subject of gastric and duodenal ulcer. Its submission to direct research has changed the whole front of our knowledge of this disease. Duodenal ulcer indeed, except as a pathological rarity, did not exist for the clinician until the surgeon revealed it. He created its clinical existence, differentiating it from those other diseases which so closely mimic it; he has devised the methods of its surgical treatment when it has proved recalcitrant. He has not only brought duodenal ulcer into the open, he has shewn its frequency as compared with gastric ulcer; he has discovered something of its most impressive antecedents; he has studied conditions which coincide with, and perhaps contribute to it. Of the morbid anatomy of gastric ulcer we had learnt a great deal from Matthew Baillie, Cruveilhier, Brinton, and others, but its clinical recognition was fraught with grave inaccuracy. Even to-day the diagnosis of "gastric ulcer" made upon clinical evidence alone is perhaps more often wrong than right. But clinical inaccuracy and bewilderment are at last yielding to patient research by the surgeon, ably supported by the radiologist. We are substituting truth for make-believe, gradually clearing away the multitudinous errors which have so long encumbered this subject. We seek to walk by sight, not by faith alone.

In surgery the hand of the beginner is heavy. In our earliest experience of gastric operations we found not infrequently that where a confident diagnosis of "gastric ulcer" or of "duodenal ulcer," had been made, based upon the clinical knowledge of the times, the stomach and the duodenum shewed no slightest lesion. A few little tags between the transverse mesocolon and the stomach were held to confirm the diagnosis; or a blanched area on the anterior wall of the duodenum was regarded as the scar of a superficial ulcer. Gastro-enterostomy, so marvellously successful in case of obstruction at the pylorus, was then performed, for at that time the short-circuiting operation was credited with almost magical therapeutic power. When the after-history of such patients was traced, the results were always indifferent or bad, sometimes lamentable. It was not long before I was driven to enunciate the doctrine that a chronic ulcer in need of surgical treatment only existed when it was "visible, palpable, demonstrable," and that surgical treatment should be adopted only when the presence of the ulcer was thus indubitable. I regret to find that in all countries there are still surgeons whose practice does not endorse this teaching.

When in my own work the "ulcer," so confidently diagnosed, did not display itself, wider search was made as soon as this became safe, other abdominal organs being in turn scrutinised. The results of this extended inquiry were most interesting. We sometimes discovered a gall-bladder full of stones, an appendix shewing advanced disease, a group of tuberculous mesenteric glands, or, again, a patch of tuberculous ulceration in the intestine, large or small. Sometimes it was an enlarged spleen of splenic anæmia, and, in rarest instances, a malignant growth of jejunum, or colon. And so by degrees we were brought to realise the inaccuracy of many clinical descriptions of intra-abdominal disorders, and of the estimates of their relative frequency. We learnt that many diseases betrayed themselves by symptoms confidently ascribed to defects in organs other than that attacked. Diseases of the gall-bladder, for example, whether stones were present or no, were found to be the cause of symptoms ascribed to the stomach. When stones were found in a gall-bladder exposed upon the operation table or in the postmortem room, and no history had been elicited of colics or of jaundice, produced by obstruction or infection, the stones were said to be "silent" or "innocent." Yet in every case where stones were present (the solitary cholesterin stone alone excepted) symptoms are caused by them. To this rule, which direct research alone has established, there is no exception. The symptoms include "flatulent indigestion," nausea, salivation, and so forth; they are symptoms in which the stomach is tacitly held blameworthy, and the gall-bladder is not inculpated. Innocence attaches not to the cluster of stones, but to the diagnostician. The recognition of an earlier phase in the clinical history of cholelithiasis than that formerly described is one of the results of direct research carried out by the surgeon.

For the vague, loose, inaccurate account of symptoms, something approaching precision could now be substituted, to the great advance of our clinical knowledge. This extended research was soon made as a matter of routine, and, to our surprise, isolated disease within the abdomen was found to be far less frequent than we had supposed.

A patient suffering from a duodenal or a gastric ulcer, or harbouring gall-stones, was discovered to have a diseased appendix. And it soon became evident that this association must not be regarded as accidental, that, indeed, the infection of the appendix was certainly the precursor, and very probably the cause, of pathological conditions present elsewhere. We now regard all ulcers and all gall-stones, except the solitary cholesterin stone, as consequences of infection conveyed from a distance. William Hunter's thesis, his application of Lister's teaching to general medicine, was true here also. For it was rare to find any patient suffering from gastric or duodenal lesions in whom a focus of infection was not present, and the evidence is now, I think, incontrovertible that it is from such centres of infection that organisms are carried to far distant parts, there to induce a gross organic lesion, whose connection with its cause seems remote and improbable, and whose symptoms completely overshadow those of the original infection, if indeed these latter have ever been present.

If now this subject is submitted to experimental analogical study, we find, at first, that there is an insuperable difficulty in causing conditions identical with those observed in man. The chronic gastric or duodenal ulcers with their seasonal variations in activity, periods of remission alternating with periods of liveliness, times of healing with times of destruction, do not occur, and have not yet been artificially produced in any animal. But the cultivation of organisms from ulcers removed by operation has had interesting results. Rosenow's work upon the elective localisation of microbes indicates that certain organs provide a more suitable culture-medium than others, that there is affinity between soil and seed.

He and his pupils, Nickel and Hufford, have shewn that there is a green-producing streptococcus which, cultivated from specimens of gastric or duodenal ulcers removed by operation, has an affinity for the stomach and the duodenum. After inoculation it causes hæmorrhage and ulceration in different species of animals. These analogical researches suggest that though other factors doubtless are at work in addition to infection in leading to the development of an ulcer, they appear to be powerless to develop the chronic form of ulcer of the stomach or duodenum unless infection is added to them or precedes them.

The operations which are practised for gastric ulcer produce certain consequences both in animals and in man, yet the two sets of results do not always or often tally. It is the cause of the condition in man, the consequences in man, the methods and the results of treatment in man which are our chief interest. These, as I have mentioned, have been the subject of direct research during and after operation, with the results that our knowledge of the disease and of its remedies, though still incomplete, is immeasurably in advance of our knowledge of thirty years ago. Direct research is here of incomparable advantage. It does not end with the completion of the operation. Patients who have undergone the operations of gastrectomy and gastro-enterostomy afford good material to the physiologist for enquiry into matters concerning gastric secretion, its composition in disease, the changes it undergoes after operation, and their effect upon digestion. Our knowledge so derived is, however, incomplete; there are gaps which can at the moment only be filled by analogical research, the methods of the laboratory expanding and explaining those of the operation table and of clinical enquiry, but by no means supplant-ing them nor yet overriding them. Incidents in the natural history of the disease, and of its progress and treatment may with great advantage be illustrated by experiment. The experimenter may set certain causes or supposed causes at work in order to discover if the effects attributed to them by clinical experience are indeed produced; operations may be practised to discover their mechanical or physiological effects, or to estimate the possible advantages of a changed method. But all knowledge so gleaned, if regarded as absolute, will lead to error or misunderstanding. It is relative knowledge, and must be tested with utmost care in comparison with knowledge established by direct observation and experiment upon man.

Experiment and observation were never more happily united than in Lister's work. The discovery by Pasteur of the fact that fermentation was due to living micro-organisms was illustrated by Lister in a variety of experiments. The method of controlling or preventing the activity of microbes within the area of operation and within wounds was studied upon man; was a piece of direct research. One germicide, or one mode of dressing after another, was tested and for a time adopted, only to be finally discarded or retained as clinical experience seemed to decide its value. For Lister realised that it is not merely killing of microbes which is to be desired; the problem is to render them inert within a wound without injury to the sensitive tissues of the body, whose helpful activities might be lessened or destroyed by the corrosive action of a germicide. A host of observers have laboured earnestly to discover new antiseptics, bactericidal power in contact with germs in a test-tube being regarded as the index or the proof of their clinical value. We know only too well how illusory are such beliefs. For the death-dealing power of a chemical agent in vitro is no measure of its full value in clinical work. Wound secretions add a new factor to the problem. Indeed, I have little doubt that so far as wound applications are concerned the value of an antiseptic is not to be gauged by its bactericidal, but rather by its antitryptic power. We do not so much seek to kill germs within a wound as to encourage the wound in its process of resistance to their attacks, to exalt the natural bactericidal power of wound discharges. This is perhaps not the best, but at the moment it is the most apposite, of the illustrations which might be given to shew the mutual interdependence of clinical and laboratory work, of direct and analogical research. To the clinician this needs no demonstration, but I fear the laboratory worker is in danger of becoming a little too eager to exert dominion in territory which his skill has not yet conquered. Lister's work is now being enlarged and perhaps completed by Almroth Wright, who, by his work on immunity, has made it clear that whereas Lister sought only to diminish or to destroy bactericidal attack, success may also be found in our increased defence against microbic invasion.

The changes that have taken place in surgery, the great increase in the number, intricacy, and scope of operations, have made it far more necessary than ever before that the surgeon should be a skilled craftsman. To practise the craft with something near perfection a man must surrender his whole life. To attain a certain facility in operative work is not difficult; to imitate the master's methods and to follow the movements of his skilled hands is within the easy competence of many. Man, Aristotle tells us, is the most imitative creature in the world, and learns at first by imitation. It is natural for us all to delight in works of imitation, but in imitation there lies a great danger. Many of the operations in surgery have now become so standardised, so perfected and simplified by a multitude of workers, that they can be imitated by others with a degree of success which, though falling short of the best, is yet by comparison with the results of a generation ago, worthy of high praise. This has unhappily led to the too frequent performance of operations, and to their performance by those whose judgment has not kept pace with their technical accomplishments. Perhaps the most abused operation in surgery is gastro-enterostomy. A distinguished continental surgeon has fathered a paper by one of his pupils on "Gastro-enterostomy, a Disease." The anastomosis is in all truth a disease, when performed in the absence of a sufficient cause, or in an inartistic and vicious manner. That it is frequently performed when not needed; that it is performed by the clumsy imitator is certain. Many of us have had the bitter duty of undoing such anastomoses, or of resecting the ulcer which has developed in consequence of them. The physician who sees such cases condemns the operation: in that surely he is wrong; his strictures and ours should fall not upon the operation, but upon the operator. I conceive that a duty rests upon the physician greater than he realises. When a physician for whose talents and devotion I have great respect expresses his regret that he could not agree with my advocacy of surgical treatment for chronic incoercible duodenal ulcer, because the mortality of the operations practised upon his cases was over 10 per cent., I was constrained to say that were the mortality in my own hands so high I should rely upon medical treatment though I realise its dangers.

There is no doubt that a change in the training of the surgeon is imminent, and is certainly overdue. What should be the approach to surgery? It has long been the custom for those waiting to obtain a post on the surgical staff of a hospital to spend months or years in teaching anatomy. And what anatomy have they been compelled to teach? "Descriptive anatomy," the bare record of the physical characters of the various structures of the human body. Students, in accord with modern custom, must be taught the origin and insertion of muscles, the origin, course, branches, and destiny of nerves; the source, divisions, and direction of vessels and the like, a dull catalogue of dead things. For descriptive anatomy has in all countries of the world, for a century, been divorced from functional anatomy. Sir Arthur Keith has told the story of this lamentable severance. The early English anatomists, from William Harvey onward, were not content merely to tell in words what any man could see with his own eyes. They were deeply concerned not only with the appearance of parts, but with the meaning attached to structure. They desired to know not only how organs of the body were constituted, but why they were so made. Their interest was engaged by the function no less than by form. John Hunter was intensely occupied with dissection, hardly a day passed without his spending many hours in studying the anatomy of parts in man, and in any animals whose bodies he could beg, borrow, or steal. But he sought to know not merely what and where the various structures were, but even more the function they fulfilled. For him, as Keith says, "it was not enough to recall that the wall of the aorta was twice as thick as that of the pulmonary artery, or that the walls of some veins were thick and of others thin: he immediately set to work to find out the significance of these facts; he appealed to comparative anatomy, to embryology, to pathology, and experiment for an explanation." On February next we celebrate the two hundredth anniversay of John Hunter's birth, and we hope then to display Hunter's own handiwork in such manner as to shew the variety of his intellectual appetite, and his unsurpassed skill in dissection. But dissection was always a search for the reasons of the actions of parts, not merely for their structure.

How then did anatomy go astray? Keith rightly traces the catastrophe to the influence of France, and to the delightful gifts of our Gallic colleagues for systematic and logical thought with orderly and luciferous expression. It seems that the determining influence was that of Winslow (1669–1760), Professor of Anatomy in Paris. His teaching, accounted the best in Europe, was eloquent, formal, precise. "Whilst merely conveying to his hearers or readers what they might see with their own eyes at a glance, he left them with the pleasant impression that they were drinking at the very fountain-head of pure knowledge." He purposely abstained from attempting to explain the meanings of the structures he described, and in doing so impoverished the study of anatomy. The standard set by him was universally followed and was to find its highest expression in one of his successors, Bichat (1771–1802). At the time when I became a student, forty-four years ago to-day, we were taught anatomy as we should be taught the plan of a city; learning the names of houses, of main streets, of their branches and turnings; by whatever gate we entered we thus learned to find our way about. But to the people who live in the city, their industries, their way of life, the part they filled in the community, we were hardly expected to give a thought. For all we knew the city might be dead.

It is true that the surgeon must know the formal anatomy of the human body, no very difficult attainment, though he will sometimes find that he still must make his own fresh investigations. When, for example, certain problems presented themselves in connection with the operative treatment of gall-bladder disease, my colleague, Mr. Flint, at my suggestion, examined in the post-mortem room 200 bodies, and was able to teach us new truths relating to the vascular supply of the gall-bladder and the anomalies of the ducts of the liver. But to be constrained by custom to teach successive generations of students the details of descriptive human anatomy, to be compelled day after day, year after year, to restrict one's teaching to the elementary parts of a finite subject, human anatomy, is insidiously to develop an intellectual complacency, a feeling that one is master of one's subject. Nothing so easily destroys a man's capacity for thought, and his delight in indulging it (it is, alas, sometimes a torture), as the restriction of his mental efforts to a limited part of a subject now hardly capable of extension. It is difficult to imagine any training less fitted in these times for the young surgeon. Anatomy as an approach to surgery cannot long continue to be the descriptive anatomy of recent years, a sterile derivative of true anatomy which embraces a study of functional activities and purposes. We must return to the anatomy of the English school, the science founded by Harvey and pursued by Hunter, Charles Ball, and Lister; the science which searched in the Aristotelian phrase for "final causes," and which tried to answer the question, "To what end"? In my days I did my best to escape from the insipid routine teaching of anatomy by devoting a part of almost every day to original work in the postmortem room and in the dissecting room, and upon fœtuses which I besought my friends in general practice to send me. I worked upon the subject of internal hernia, and upon the rarer forms of external hernia. And I was saved from the cramping influences of the dissecting room by the surprising desire of many medical men to surrender their patients to my immature skill at a time when abdominal surgery, having survived the dangerous pioneer period through which it had just been steered by Spencer Wells, Lawson Tait, and Mayo Robson, was at length becoming so safe that many diseases hitherto beyond the reach of the surgeon were now being successfully attacked. But all my life I have wished that my training had been different. Were my days to come again I should, after leaving examinations behind, spend the time necessary to make an adequate knowledge of human anatomy my permanent possession, and I should then escape to experimental research, and in a community of like-minded people endeavour to train myself for the high destiny of a surgeon, the one man who may engage in direct research. My time would be spent in the laboratory, where a youth of plastic mind may learn the methods of approach to new problems, or to new extensions of old problems; where old knowledge is merely an impulse to the search for new; where intellectual dissatisfaction is victor over narrow complacencies; where the religion of research inspires him and equips him for his work in days to come. If surgery is to be something more than a wonderful craft, if it is to be the instrument of research which I believe it to have been, and to be destined to be in the future, those who practise it must have their minds shaped and strengthened by conflict with unsettled problems, not cramped and sterilised by monotonous exercise within a narrow province of static knowledge. Their minds must be trained in the laboratory, in analogical research, so that they may be more effectively exercised both in the operation theatre and in the wards upon direct research, not I need hardly say to neglect of the dissecting room, but to its relegation to a subordinate position. The comradeship of laboratory workers and clinicians should be intimate and unbroken. The scientist at work in the laboratory can never reap the full reward of his lonely researches without close and loyal collaboration with the clinician. Nor can those who serve the same cause in a different atmosphere give to their patients the best aid of medicine and surgery without the help of the scientist. The training of the surgeon must not only allow, it must urge, his mind to stray beyond the hard boundaries of old knowledge, over the edge of firm beliefs, into wide territories as yet unexplored and even undivined. In this way only is their escape from the danger which besets the surgeon in the future, the peril of a facile automatism. In this way may the physiologist be brought back from his vagrancies and encouraged to realise that his science best fulfils its destiny when it is applied to the understanding of the functions, normal and aberrant, of the organs of man. It is a delight to me to see that a few of the younger surgeons in this country are taking the path which I should follow if I were on the threshold of a surgical career.

Lister was thrice, four times, happy in growing up under the sway of men steeped in the old ideals of anatomy. The intellectual influences of his life came from Sharpey, and from Wharton Jones, dirty, despised, yet passionate in his zeal for the discovery of truth by way of experiment. Like their teacher, Alexander Monro (secundus), these men never wearied in the search for reasons. They were not content with mere knowledge of the construction of parts, but in that knowledge sought the clue to the several actions of which those parts were capable. In Lister's early papers, "Observations on the Contractile Tissue of the Iris," "On the Muscular Tissue of the Skin"; "An Inquiry Regarding the Parts of the Nervous System which Regulate the Contraction of the Arteries"; "An Inquiry into the Functions of the Visceral Nerves," we see clearly that he was carrying on the high tradition in which he was trained. I have not gained the impression that Lister was a man of really exceptional intellectual gifts. Rather was he a man of great intelligence trained in the very manner which helped his mind to work to highest advantage in his special calling. Advances in medicine and surgery are made by men who to the faculty of observation add the power of conceiving and carrying out experiments, not in the laboratory only, but also in the operation theatre and in the wards. For disease and accident alike may be regarded as beginning experiments for us; and it is for us to add factors of our own devising, to exert influences designed to check or to change the course of events, and in so doing to judge both causes and effects, and the range of our power over both.

No training of the surgeon can be too arduous, no discipline too stern, and none of us may measure our devotion to our cause. For us an operation is an incident in the day's work, but for our patients it may be, and no doubt it often is, the sternest and most dreaded of all trials, for the mysteries of life and death surround it, and it must be faced alone. Those who submit to operation are confronted, perhaps after long and weary days or months of suffering, with the gravest issues, and far more often than many of us suppose they pass into the valley of the shadow of death, and, in stark dismay, wonder with Beatrice in her aching solitude and panic, what will come to pass

> "If there should be
> No God, no Heaven, no Earth in the void world,
> The wide, gray, lampless, deep, unpeopled world."

To give courage to those who need it, to restore desire for life to those who have abandoned it, with our skill to heal disease or check its course, this is our great privilege. Ours are not the mild concerns of ordinary life. We who, like the Happy Warrior, are "doomed to go in company with pain and fear and bloodshed," have a higher mission than other men, and it is for us to see that we are not unworthy.

* The opening address at Kings College Hospital, delivered September 30, 1927.

LISTER—BENEFACTOR OF MANKIND*

During this week we have been celebrating the centenary of the birth of Joseph Lister, and scientists and medical men from the whole civilised world have met in London to do homage to his memory. Who was Lister? What, exactly, did he accomplish? What place in history will posterity assign to him?

It may sound a little startling to many who have rarely heard his name, or have only vaguely connected it with some method of surgical treatment, to learn, what is undeniably true, that Lister is the greatest material benefactor of mankind the world has ever known. How is it possible to justify a claim that may seem extravagant?

Joseph Lister was born on April 5, 1827, of Quaker parents, was the son of Joseph Jackson Lister, who did much to improve the design and power of the microscope, and so put into our hands an instrument by which we are able to study the minute structure of animals, plants, metals, and so forth. He was, therefore, brought up in a quiet, domestic atmosphere, and learnt, in his earliest days, something of science and the endless problems it presents for our consideration. Lister from his childhood desired to be a surgeon, and, at the age of seventeen, joined University College, London; a nonsectarian school, one of the few from which, as a Quaker, he was not debarred. At the age of twenty-one, after taking an arts degree, he began the study of medicine. He was fortunate in his teachers in the medical school, especially Sharpey, and Wharton Jones, who encouraged him to work on the scientific aspects of his profession.

After nine years of study he graduated at the London University, and at the Royal College of Surgeons, was appointed House Physician, and then House Surgeon at University College Hospital, and afterward left for Edinburgh to become private assistant and House Surgeon to James Syme, Professor of Surgery in the University, and the "safest surgeon of his day."

In those days the word "safety" was singularly inapplicable to the practice of surgery. It is, I think, impossible for us to realise how great were the horrors of surgery a century ago. The number of operations practised then was very few, because of their very heavy mortality, and their almost insupportable burden of suffering and of terror. The great majority of operations now practised had not then been conceived, and some of those which are now performed daily, and are almost or entirely free from risk or anxiety, were then so dangerous that, only fifty years ago, the managers of hospitals refused to allow the surgeons on their staffs to perform them. The opinion of the leaders of the medical profession sixty years ago was voiced by our leading professional journal, which spoke of such operations as "murderous," and of the surgeons who practised them as guilty of offences which should be classed as manslaughter. If one reads the biographies of surgeons of a century or more ago, one is struck by the apprehension they shewed when any operation had to be performed, and of the anguish of mind which possessed them for days before and afterward. Let me recall an instance:

When, in the year 1821, Astley Cooper operated upon George IV for a small sebaceous cyst on the head, so tortured was he by anxiety lest erysipelas or pyæmia might develop, that he sought to put upon others the responsibility of the operation. He speaks of the operation in terms which, to us, now appear absurd, fearing that "it might, by possibility, be followed by fatal consequences." He says, "I saw that the operation, if it were followed by erysipelas, would destroy all my happiness and blast my reputation," and "I felt giddy at the idea of my fate hanging upon such an event," and again, "I am certain that if anything happened to the King, that, at any rate, I should leave London and live in retirement."

It is hard to believe that a surgeon eminent enough to be chosen for service to the King should be so deeply moved at the prospect of what was to him as it is to us, technically, the simplest of operations. The exercise of the art of surgery then brought terror where it now brings joy, to surgeon no less than to patient.

The hospitals of those days were the breeding grounds of mortal pestilence, which struck down whole wards full of patients, and made of them a place of dread. A distinguished Edinburgh surgeon, in the middle of last century, spoke of a hospital as a "house of death." Lister himself said that hospitals were little short of pest houses, and over and over again the wards of hospitals, or even the whole hospital at home and abroad, had to close until the plague abated. The most eminent French surgeon of his day, speaking of the dangers of even the slightest wounds, said, "A pin-prick is a door open to death," and that the performance of an abdominal operation should be "classed among the methods of the executioner." Sir James Simpson, of Edinburgh, the discoverer of chloroform's anæsthetic power, said, "The man laid on an operation table is exposed to more chances of death than a soldier on the field of Waterloo."

In those days the infection of a wound made by the surgeon caused the gravest apprehension, because infection, blood-poisoning, in greater or less degree, was almost certain to follow. A case of compound fracture of any bone, a fracture, that is, with a wound leading from the surface to the point of fracture, had a terrible mortality. All such wounds, whether caused by accident or made by design, became inflamed, became, as we say, septic, and discharged matter freely. The free discharge of pus was, indeed, regarded as a good sign; the poison finding in that way a free escape from the wound. The poison, if retained in the wound, might spread to other parts, to glands, to joints, to the blood-stream; so that hospital gangrene, erysipelas, blood-poisoning were rife throughout the hospital, and the death rate was appalling. The suffering and the sorrow inseparable from the surgery of that time are exquisitely described in a book that all should read, "Rab, and his Friends," by John Brown.

This condition of inflammation and putrefaction in wounds had received the closest attention of surgeons from time immemorial. All sought to discover how it arose, and by what means it could be prevented. The generally accepted belief was that the decomposition of wound discharges, resulting from infection, was due to the presence of oxygen in the air; and, since air could not be prevented from having access to wounds, the disastrous events were unavoidable.

A French investigator, the immortal Louis Pasteur, who was then at work in Lille, the centre of many distilleries, was led, in the year 1857, to study the process of fermentation. By a series of remarkable experiments he was able most clearly to demonstrate that it was the activity of living particles, whose growth and propagation was the cause, and the only cause, of this process. Lister, who had spent many years in the study of inflammation, and of suppuration in wounds, was quick to see that this new discovery, ridiculed and denied by others, had a cardinal importance in connection with wound infection. This is what he said in 1867:

"In the course of an extended investigation I arrived, several years ago, at the conclusion that the essential cause of suppuration in wounds is decomposition brought about by the atmosphere upon blood retained within them. To prevent the occurrence of suppuration, with all its attendant risks, was an object manifestly desirable, but till lately apparently unattainable, since it seemed hopeless to exclude the oxygen which was universally regarded as the agent by which putrefaction was effected. But when it had been shewn by the researches of Pasteur that the septic properties of the atmosphere depended not on oxygen or any gaseous constituent, but on minute organisms suspended in it, which owed their energy to their vitality, it occurred to me that decomposition in the injured part might be avoided without excluding the air, by applying, as a dressing, some material capable of destroying the life of the floating particles."

The problem which now presented itself to Lister's mind was clear. If wound infection, with all its attendant horrors and dangers, was, indeed, due to living particles propagating on the wound surfaces, and in the wound discharges, then the destruction of these microbes, as Lister called them, within the wound would prevent the terrifying, and often lethal, series of events which were regarded as inevitable. Lister accordingly sought for some "antiseptic," as it was called, for some chemical agent, carbolic acid salts of mercury, and so on, which would kill the germs. The problem, however, was not so simple as it seemed. An antiseptic which would kill a germ, or at least prevent its growth, was found to lose a great part of its power when applied to a wound which was freely discharging matter. The wound discharges reduced, or even abolished, the power of the antiseptic; and the antiseptic itself, if applied in strong solution, caused actual corrosion of the wound surface. Lister was made the object of bitter criticism, and scorn, ridicule, and contempt were passed upon his methods of treatment. Like most of the great discoverers, he met with open hostility, and the most ignorant and remorseless opposition. But quite undismayed, and serenely indifferent, he worked unceasingly at his task, and little by little realised that his next step must be toward a goal rather different. He now sought not to destroy the germs in the height of their malignant activities in the wound, but to destroy them before they entered the wound. These germs exist everywhere, upon the skin, in the clothing, in the air, upon instruments, as they are taken directly from the cupboard shelves, upon sponges used to dry the wound, upon or within everything that touched the wound surfaces.

The killing of germs in or upon dead material, sponges, ligatures, instruments, presented no such difficulty as was encountered with their attempted destruction within the wound. When, therefore, a wound could be deliberately inflicted, and the living germs denied access, the whole practise of surgery was revolutionised at once. Wounds were found to heal by what is called "first intention"; infection disappeared or was greatly reduced, hospital gangrene, blood-poisoning, and erysipelas vanished from the surgical wards. Not only were the operations then practised made safe, but it was soon evident that the "murderous" operations were robbed of almost all their dangers. The cavities of the body, the abdomen, the chest, the skull, which before no man dare enter, could now be laid open by the surgeon, and the disease which affected them made subject to his skill. The change in outlook and in accomplishment were incredible. Diseases, from which there was no release save by death, were eradicated, and life and health restored to the sufferer. New knowledge grew apace. For in the days before Lister the only knowledge we possessed of many diseases was gleaned from study of them after they had brought life to an end. Now it became possible to see them, handle them, study them during the lifetime of the patient; to discover their earliest manifestations, to eliminate them, even to prevent them. A new vision came to us all, and a new power was put into our hands: the power of restoring health, of subduing pain, and of keeping death itself at bay.

Perhaps a multitude of people listening to me tonight bear upon their bodies the scar made by a surgeon, who has operated upon them for appendicitis, for a tumour, for a deformity, for any one of a hundred ailments. That scar is the caress of Lister's hand. It is he who gave your surgeon the power to heal you and to save you. You are a living memorial to the genius of Joseph Lister, and a witness to his triumph over human misery and disease. If you consider the change that has come over the hospitals of the world, how they have grown, how they are no longer houses of death, but homes of happiness and health, how many hundreds of thousands pass through them every year, how, for almost every hospital in the country, there are long lists of those who wait for admission, confident in the knowledge that the means of rescue and relief are at hand, you will begin to measure the debt we owe to Lister.

Every country in the world is carrying out the work which Lister made possible. I said of him many years ago that he had been the means of saving more lives than all the wars of all the ages had thrown away, and that still remains true even after the merciless sacrifices which were asked of many nations in the late war. Lister has been the means of relieving more pain than all the drugs that ever were known. He has placed in our hands a power for good, greater than has ever existed in the world before. He has enlisted under his banner an army whose willing recruits come from every civilised country on the globe. He created a League of all the Nations which will endure forever. Hour by hour, day by day, we fight under his leadership, and till the end of time we shall continue to conquer in our fight against the perils, the suffering, the misery, caused by injury and disease. The profession of medicine is rightly jealous of its proud and ancient title of nobility. No nobler service has ever been rendered to the human race than that which Lister gave. Mercy is nobility's true badge. It was Lister who opened the gates of mercy to mankind.

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* Broadcast Speech delivered Friday, April 8, 1927, 9.15 P. M., during the London Celebration of the Lister Centenary, 1827–1927.

PERFORATION OF GASTRIC AND DUODENAL ULCERS *

The perforation of an ulcer of the stomach or duodenum may be acute, subacute, or chronic. It is *acute* when there is a sudden rupture of the base of the ulcer, and the contents of the viscus are free to escape into the general cavity, and do so. It is *subacute* when the rupture is exceedingly minute; when it occurs after adhesions have been formed around the base of the ulcer, or when the little rent is quickly closed by a plug of omentum or lymph, and the escape of the contents of the viscus is therefore circumscribed and the general peritoneal cavity is not contaminated. It is *chronic* when so firm an adhesion has formed between the ulcer and the abdominal wall, the pancreas, or a neighbouring viscus, that the base of the crater is no longer formed by the stomach, but by the parts to which the stomach adheres—the pancreas, the abdominal wall, the liver, the gall-bladder, etc. When a hollow viscus has adhered to the stomach, a chronic perforation results in the formation of an internal fistula.

Acute Perforation.—This form of perforation may occur either in acute or in chronic ulcers. It affects chronic ulcers far more frequently than acute ulcers. The condition is therefore one of acute perforation in a chronic ulcer. It is necessary to be precise upon this point, for the literature of this subject contains many inaccurate assertions that perforation occurs in acute rather than in chronic ulcers. In twelve consecutive years at the Leeds Infirmary (1910–1921) there were 61 deaths from perforation of a gastric ulcer; in 60 cases the ulcer was of the chronic variety. There were 117 deaths from perforation of a duodenal ulcer. In 12 of these cases there was an acute ulcer; in 4 of the 12 there was a chronic ulcer also, and it was in every case the chronic ulcer which had perforated. In 8 cases an acute ulcer had perforated. In my own list I find that the great majority of the cases of chronic ulcer which perforated had undergone medical treatment for longer or shorter periods on one or more occasions. The same experience has occurred to Sherren,[1] who records "218 cases of perforated duodenal ulcer treated at the London Hospital; in 6 only was there no previous history of indigestion. Similar figures were obtained in 248 cases of perforated gastric ulcer. In hæmorrhage due to a chronic ulcer the same applies. As the majority of these patients had had more than one course of medical treatment, several had been having intermittent treatment for ten years and 1 for thirty-two, we are perfectly justified in considering them failures of that treatment, and if surgery was unable to be employed successfully in these emergencies, the mortality is medical rather than surgical." Walton[2] found that of 79 cases of gastric or duodenal ulcer which were fatal, 78 were seen on postmortem examination to have ulcers of the chronic variety.

It is certain therefore that the perforation, whose symptoms and treatment we are to discuss, is concerned, as a rule, with chronic rather than with acute ulcers. It is equally certain that perforation is consequently a preventable complication. For chronic ulcers of the stomach and duodenum should never be allowed to progress to the late stage in which this catastrophe occurs, and regard should be paid to any exacerbation of symptoms which may suddenly appear, for these are often the clear warning of that increase in pathological activity in the ulcer which ends in the rupture of its floor. As an increase in pathological activity should never occur whilst a case is actually under medical treatment, perforation of a chronic ulcer should then be impossible. When perforation occurs during such treatment the ulcer is almost certainly malignant. The clinical records in cases of extreme surgical emergency with high death-rates are necessarily imperfect, but, so far as can be judged, it is safe to assert that not less than one-fourth of the total number of cases of perforation are heralded by such an increase in the severity of the recurring symptom, pain, that suspicion should be aroused as to the imminence of danger.

The acute perforation of an ulcer is a terrible catastrophe. The patient is plunged at once into a condition of prostration and of unendurable agony that, with one exception, are unsurpassed in human experience. The pain is almost beyond description. It seizes the patient in a moment, and deals him a blow that he himself may think is mortal. It attacks the whole of the abdomen, and is especially severe "in the upper part; it is described as 'tearing,' 'racking,' 'bursting,' 'horrible,' 'everywhere'"; it spreads over the lower part of the chest and even up to the shoulders. Within a moment or two the patient's appearance betrays his suffering. The face is pale, haggard, anxious, and appealing; the eyes are wide and watchful; the brow and temples are bathed in sweat, the hair soaked. Horrible suffering quickly delves deep lines upon his cheeks. The patient struggles for breath in short, panting respirations which are chiefly costal, the diaphragm making no slightest movement. The nostrils are wide, the mouth shut, and every expiratory effort is audible. He complains of cold, and feels cold when a hand is laid on him. The thermometer registers 96 degrees or even a little lower. No movement is made that can be avoided, and words are spoken only in the shortest expiratory jerks, every syllable being part of a deep groan. If a hand is stretched out to touch his body, the patient shrinks from an added terror, and will protect himself as best he can with his arms. His legs are soon drawn up. He reaches the very limit of human power to withstand suffering, and his appearance arouses the very gravest anxiety as to his state, and may even suggest that death is hastening to him. The condition, indeed, is one for which no other word than "shock" seems fitting. Yet shock in the surgical sense is absent. Shock used in its strict sense means the condition in which an increased pulse-rate, a diminished blood-pressure, and a reduced blood volume are present. Not one of these is found in the first hour or two after a perforation has occurred. The rate of the pulse is found to be normal, its quality, as a rule, good; the blood-pressure is within normal limits. The blood volume has been measured in only a few of our cases, but that too shows no change. It is, therefore, inadmissible to use the word "shock" without qualification to describe the state of a patient who is in the toils of this terrible calamity. Shock is a word used loosely enough. We are "shocked" to hear distressing news; we are said to be shocked when we mean that we are surprised. But these loosenesses are not justified in surgery. "Shock" is a word used by the surgeon with a definite significance and has no other. Used in its strict sense, the word "shock" is accordingly not permissible as describing the state of a patient in the early period after a perforation has taken place. This must be clearly understood; for every surgeon with large experience knows that a medical man called to see a patient in this stage has deferred his diagnosis of the condition because of the normal pulse-rate. It has hardly seemed credible to him that so grave a catastrophe as perforation could occur without "shock," and shock he has always heard is an invariable symptom when an ulcer has ruptured. There is, of course, the most terrible prostration. Perhaps, apart from severe hæmorrhages, no disease except acute pancreatitis (in which true shock is present) produces so profound a degree of prostration. We must, therefore, not less in the interest of accuracy than in that of the welfare of the patient, cease to use the word "shock" in this connexion. Let us speak of prostration, a word which has only a clinical significance. Shock, it is true, comes later in these cases; it comes when peritonitis has developed. But peritonitis is not perforation: it is a late and preventable sequel to perforation. It is the perforation we seek to recognise, the peritonitis we seek to forestall.

The examination of the abdomen in this stage reveals a characteristic condition. The muscles are in sternest rigidity. The hand travelling gently over the abdomen finds no soft or yielding area. Every part offers the most inflexible opposition to pressure; the rigidity is obdurate, persistent, and unyielding. There is no movement. The diaphragm, largest and strongest of abdominal muscles, is as rigid as the rest, and the shallow, frequent respiration finds in this its explanation. All parts too are tender, though the upper abdomen is, as a rule, definitely more sensitive than the lower. One side of the upper abdomen may be a little more resistant, and a little more tender than the other. And this may help to decide whether it is a gastric or a duodenal ulcer which has given way. Only the most gentle examination is permissible; it is unnecessary, and indeed inhuman to do more, for the diagnosis of a surgical emergency requiring immediate relief is beyond doubt, and the sooner a dose of morphine is given, and preparation made for operation, the better.

The period of initial prostration varies in different cases, and its length depends no doubt upon many factors: the size of the perforation, the condition of repletion of the stomach, the general powers of resistance of the patient, etc. As a rule it lasts not less than an hour, and rarely more than two hours. It is followed by a period of reaction. Little by little the pain subsides, though still remaining very severe, the sharp edge of it is blunted. The cold greyness or pallor of the face is followed by a slight flushing, and indication that the general circulation is becoming more vigorous. The pulse-rate rises, the limbs grow warm, the temperature reaches or slightly exceeds the normal. Relief from an agony that has almost passed belief may persuade the patient that all is well. The victim lifted from the rack fell asleep, though his residue of pain would have seemed acutest suffering but for its comparison with the far greater agony from which he had just escaped. Pain in this period is still present and severe enough. The abdomen is steadily increasing in size, and its walls have still the same incoercible rigidity as before. Respirations remain hurried and shallow, for the diaphragm is now pressed upwards by the fluid and gas which are beginning to accumulate within the peritoneal cavity. Fluid has gravitated to the pelvis, and the peritoneum there, acutely inflamed, may be recognised as exceedingly tender if a rectal examination is made. It is in this stage, as a rule, that vomiting first appears. This symptom is by no means frequent, and is very rarely severe. The abolition of liver dulness is often asserted to be a sign of great value in the diagnosis of a perforated ulcer. It appears at a time when the diagnosis should be made without any difficulty; it is a late and not an early sign. Resonance above the edge of a liver which can be felt is not unusual when gas is present in loops of large or small intestine which creep towards the diaphragm; and to percuss in the midaxillary or posterior axillary line means discomfort to the patient who should be spared all unnecessary disturbance. On the operation table, resonance over the liver between these lines will often be found in the case where delay has occurred. Free gas within the peritoneal cavity will rise to the highest part. If the patient lies flat on his back, it will ascend to the umbilicus; if he is sitting upright, it will collect beneath the diaphragm, or make the best attempt possible to do so, though it may be prevented by adhesions. If it succeed, then the liver dulness will diminish in proportion to the amount of free gas present; on the left side the splenic dulness, rarely a very definite area, will disappear also. The value of percussion is, therefore, to be regarded as important if it shews an absence of liver dulness, especially if an hour or two before the dulness has been recognised, but unimportant if the liver dulness is found normal. In other words, the loss of liver dulness as a positive sign, in the absence of meteorism, is significant, even decisive; the presence of liver dulness neither helps nor denies a diagnosis.

As time passes the state of the patient grows progressively and rapidly worse. Vomiting may be repeated, and hiccough, sometimes exceedingly distressing, may develop. The abdomen grows larger and larger, fluid may be present, and a shifting dulness may indicate its quantity. The face grows hollow and the expression strained and weary. The features appear sharp, the skin is livid and sweating, and is often cold and clammy. The pulse deteriorates in value and increases greatly in frequency. The whole condition and appearance of the patient indicate the extreme gravity of the case, and a fatal ending may be expected within three or four days unless operative measures can bring relief.

The duty thus laid upon our profession is clear. We must take pains to become familiar with the signs and symptoms of chronic ulcer of the stomach and duodenum, so that this lethal catastrophe may be prevented. The perforation of a gastric or duodenal ulcer is preventable in the large majority of cases; it is an evidence therefore of neglect somewhere; of neglect on the part of the patient to attend to his own malady by consulting a medical man, or to follow advice which has been given to him. It is an evidence of neglect on the part of the medical man if he has failed to recognise the condition, and to give appropriate counsel when the patient has consulted him. It is an evidence of neglect on the part of the physician if he has not given utmost emphasis in his advice to the truth, that it is not only a relief of symptoms which the patient must consider, but also the healing of the ulcer, and that this may be a matter of many weeks, and not only of a few days. It is not a matter of importance that we should have an equal knowledge of all diseases; it is important that all who are in general practice should have the clearest knowledge of the diseases which immediately and irrevocably assail human life. It is as important to know the full truth about ulcers of the stomach and duodenum, as it is to know how hæmorrhage may be arrested, or how strangulation in a hernia may be recognised. If we fail to recognise an obscure lesion of the brain or spinal cord, a few days' grace may be allowed for our study of these conditions; but failure to recognise the emergencies that we are now considering means the loss of a man's life. Not less than 90 per cent. of cases of perforation affect chronic ulcers. These ulcers should have been recognised months or years before this late complication in their history. Many patients have been treated for these conditions; some have been treated over and over again. Few have been urged to recognise the menace of the disease, its tendency to recur, the necessity for protracted treatment until weeks or, perhaps, even months after symptoms are in abeyance. The position is serious, as a contemplation of hospital reports from all parts of the country will shew. It is our bounden duty to do what we can to improve it.

After perforation has occurred, there should be no difficulty in making a diagnosis of sufficient accuracy to dictate a policy of action. It is important only to know that something has happened within the abdomen which cannot be relieved by any other than surgical measures. It is not important to know whether it is a duodenal or a gastric ulcer that has ruptured; or whether the pancreas has suffered an acute hæmorrhagic inflammation, or whether the appendix is sphacelated. All these things can be recognised at once when the curtain of the abdominal wall is lifted. The one essential thing is for the medical attendant to recognise that something is threatening life, and that the sooner the threat is removed the better. All the symptoms and signs related above should be remembered; but for a policy of action it is enough to know that when an acute intolerable attack of agony comes suddenly, and the abdominal wall is at once on guard, intensely resistant and unyielding, and everywhere tender, the cause may be this or that, but the remedy lies in operation and in operation alone. We must disabuse our minds of the belief in the presence of "shock," if the word is used in its surgical sense. If we use the word to indicate the appearance and not the state of the patient, then, and only then, can we say that the victim of a perforation suffers from shock. There is no doubt that a condition is present, whatever name we attach to it, which makes the ordinary surgical procedures carry a risk greater than that which ordinarily attaches to them. But the danger is that if we allow ourselves to suppose that shock must be present before we are entitled to diagnose the existence of a perforation, then we shall be permitting a patient to drift into the condition of shock that develops some hours later, and only then shall we be able to make a diagnosis. And these hours of delay may cost a patient his life. Many of those who have recorded their experiences have arranged their cases in groups representing operations performed within six hours, between six and twelve hours, between twelve and twenty-four hours, and over twenty-four hours. All such tables shew a gradually rising mortality. After forty-eight hours the mortality falls a little, for the clear reason that cases surviving so long are, in truth, examples rather of subacute than of acute perforation.

What is the cause or what are the causes of the symptoms and signs which are called forth in an acute abdominal crisis? They are the result of disturbed reflexes.

The organs affected, as Mackenzie, Head, Hurst, and others have shewn, are themselves insensitive to pain, and make no response to stimuli which applied to the skin would be intolerable. The effect of the application of stimuli to a viscus is expressed in terms of pain, hyperæsthesia, and tenderness in the cutaneous nerve, which is associated with the sympathetic nerve supplying the viscus. The viscera concerned in any of the grave abdominal crises are associated through their sympathetic nerves with the lower six dorsal nerves, which through the anterior and posterior branches supply the skin not only of the abdominal wall, but of the back. If we know the sympathetic nerve supply of any viscus, as we do, we shall also know the spinal nerve with which it is associated; and as it is the spinal nerve which speaks for its silent associate, we shall know the area of distribution of the cutaneous sensations provoked by irritation of each sympathetic nerve; and vice versa, if we know the surface manifestation we know also the viscus at fault.

The stomach, for example, receives its sympathetic supply from the nerves associated with the fifth, sixth, seventh, and eighth dorsal nerves; these nerves will, therefore, express by pain, hyperæsthesia, and tenderness any irritation to which the sympathetic is subjected. The spinal nerves are distributed over an area which extends in front from the xiphoid cartilage to an inch or more above the umbilicus, and behind from the fifth dorsal spine to the tenth. The duodenal supply corresponds to the ninth and tenth dorsal nerves; and this in front affects the skin above and around the umbilicus, and behind is related to the eleventh and twelfth dorsal spines. The small intestine is related to the eighth, ninth, tenth, and eleventh spinal nerves, whose area in front extends from above the umbilicus to the lower part of the hypogastrium, and behind extends from the ninth dorsal spine to the second lumbar spine, inclusive. The gall-bladder and the bile-ducts are in relation to the seventh, eighth, and ninth spinal nerves. The diaphragm supplied by the phrenic nerve is brought into association with the third and fourth cervical nerves, from which the phrenic nerve springs. A reflex pain may, therefore, be referred to a zone which extends from the nape of the neck to the seventh cervical spine behind, embraces the supraspinous fossa and the acromio-clavicular region laterally, and in front lies above the sterno-clavicular articulation. The visceral peritoneum shares the sympathetic supply of the organ which it clothes. The parietal peritoneum, however, is supplied by the spinal nerves, and, together with the loose connective tissue lying external to it, possesses a lavishly distributed plexus. The visceral peritoneum may suffer much injury, through incision, the application of the cautery, and so on, without conscious response; the slightest injury to the parietal peritoneum is acutely resented, and the severest pain is felt when it is put upon the stretch.

When a gross destructive lesion affects any viscus, the sympathetic nerve or nerves communicate their misfortune to the spinal associates, who at once raise the alarm. The reflex experienced may be sensory or motor. The viscero-sensory reflex is expressed in hyperalgesia, the viscero-motor in muscular spasm, that is, rigidity in the implicated area. As soon as the parietal peritoneum is involved, however, the effects produced are no longer reflex, but are direct, since this membrane is possessed of its own spinal nerve supply. A frequent and convincing illustration of this truth is seen in cases of acute appendicitis. The initial acute pain indicating obstruction, gangrene, or perforation is felt in and especially a little above and around the umbilicus; at a later stage, and only in a later stage, are the signs and symptoms localised in the right iliac fossa. So true is this that it may be accepted as very probable that when an acute attack of pain is first felt in this fossa the cause is not to be found in disease of the appendix.

The detection of cutaneous hyperalgesia, the viscero-sensory reflex, in any area requires a certain skill. It may be gauged by stroking the skin with a pin held at an angle with the surface; a vigorous scratch must be avoided, for that would discover sensitiveness in all. A short, gentle stroke is first made on the normal skin of the chest or thigh, and then on the abdominal wall. A better method is to pinch a little fold of skin lightly between the thumb and forefinger and draw this away from the underlying muscles. If a disturbed reflex is present it causes the patient to wince; a quick involuntary movement is made, or a hand lifted to protect the tender part. This method has the advantage that, pressure over the parietal peritoneum being avoided, hyperalgesia can be differentiated from tenderness.

These procedures have a value which is very differently appreciated by different observers. They are said by some to "tell you nothing," by others to be "very valuable." A good deal depends upon the stage of the condition in which the examination is made, and perhaps even more upon the care with which it is made. In the earlier phases of any acute condition when this is strictly localised, they do, beyond doubt, give definite indication as to the viscus which may be involved; in a later stage, at a time when the effects of the initial lesion are widespread, and this is the usual condition, they give no help and may even be confusing. The viscera, themselves insensitive to pressure, may yet appear to be tender to pressure. This is due to the implication of the parietal peritoneum which lies over them, and the more acute sensitiveness of its nerve plexus, which develops in consequence of this. There is need, therefore, for a clear distinction to be made between cutaneous hyperalgesia and local tenderness. The one is a reflex, the other a direct effect; one is aroused in a viscus by a lesion which stimulates the sympathetic nerve or nerves, and this in turn stimulates the spinal nerve with which it is associated; afferent and efferent impulses are both at work; the other is a purely local effect excited by local causes, or expressed by a keener sensitiveness in the local nerve distribution. The viscero-motor reflex is produced in exactly the same manner as the viscero-sensory reflex. The sympathetic nerve conveys the afferent impulse to the spinal segment involved, and this in turn communicates the impulse to the motor cells, which pass it to the peripheral nerve. The muscular spasm which results appears at once.

On one occasion I observed the patient at the very moment when perforation of a duodenal ulcer occurred. Within half a minute a hand placed upon the abdomen found it everywhere in a state of extreme rigidity. This intense rigidity and immobility seemed rather more extreme in the upper as compared with the lower part of the abdomen, but the difference was slight. At the operation, within an hour, there were signs of the escape of fluid from a large gap in the duodenum, downward to the iliac fossa and 2 or 3 pints of almost clear fluid were present in the abdomen. This free escape of fluid, probably exceedingly irritating to both parietal and visceral peritoneum, accounts for the development of a general abdominal rigidity rather than of a local muscular rigidity, which one would expect to find if there were only a limited area of sympathetic irritation in the affected viscus. All the abdominal muscles appear to be implicated from the first in cases in which there is free leakage from any viscus. When the acute lesion remains localised, abdominal rigidity too may be localised. In appendicitis, for example, where an acute gangrenous condition may exist before actual perforation, both cutaneous hyperalgesia and muscular spasm are more definitely localised than they ever appear to be in those cases in which the base of an ulcer of the stomach or duodenum has been rent. The peritoneum does not appear to be equally sensitive to contact with all fluids. The acid gastric contents irritate it most, extravasated blood the least. Urine escaping from the intraperitoneal laceration of the bladder never produces any impenetrable rigidity of the abdominal muscles, nor does the bile which leaks from a burst gall-bladder.

The abdominal rigidity present in cases in which an ulcer has perforated is exterme. No handling, however gentle, however prolonged, discovers one instant of yielding. The muscles remain immobile and unrelaxed throughout; and the diaphragm, strongest of all abdominal muscles, is equally inflexible. The whole contents of the abdomen are surrounded by fixed, firm, unyielding walls, which make no concession to the gentlest hand. The spasm provides the perfect muscular splint for the affected viscera. When this degree of rigidity is present, it infallibly indicates the presence of a lesion requiring surgical assistance for its relief. To this truth there is in my experience no exception. Universal unyielding abdominal rigidity indicates an intraperitoneal catastrophe. In the first few hours no measures other than those of general anæsthesia, and even those with difficulty, can abolish this rigidity. A large dose of morphine may lessen it; it seems powerless to dissipate it completely. This is fortunate, for other symptoms and signs, especially after the administration of an anodyne, and even without this, are apt to fade away, or perhaps to disappear in the stage of reaction. Rigidity remains. It is as true an indication of the presence of a crisis as all other signs and symptoms combined. No practised hand finds any difficulty in distinguishing this form of rigidity from the stiffness of an abdominal wall voluntarily brought about by the patient during an examination which is expected to cause discomfort. If in such cases the hand is kept at rest on the abdomen for a few moments, especially when the patient's mind is distracted by questions, a yielding now and again, especially at the end of expiration, is soon discovered. No voluntary rigidity is ever so incompressible as that excited by a viscero-motor reflex. When the patient is asked to breathe deeply, the free movement of the diaphragm will shew that no rigidity affects it. And the diaphragm is as much an abdominal muscle as any. If others are rigid because of a viscero-motor reflex the diaphragm, too, will be motionless.

Differential Diagnosis.—There are many acute abdominal catastrophes; disasters which affect the stomach, duodenum, gall-bladder, pancreas, intestine, appendix, pelvic organs, the spleen, the kidneys, in fact, all the viscera brought into relation with the peritoneum. When calamity comes, it is an advantage to be able to recognise the nature and the locality of the lesion; but it is exigent that we should recognise that what has occurred, wherever its origin, is something which gravely and most urgently threatens life. To make an accurate anatomical and pathological diagnosis is a delight; to reach a decision that, wherever and whatever the trouble, the sooner measures of rescue are adopted, is a cardinal obligation. We must, in brief, know what to do rather than what has happened if only one of these is to be known. This much it is essential to say, for we sometimes hear of a delay in action because the medical man "did not quite understand what had gone wrong." If this attitude is adopted, the whole problem will be simplified and the results of surgical treatment will be very greatly improved. The conclusion that a disaster has taken place within the abdomen, and that it is irremediable by any other than operative measures is not difficult to reach. It may be impossible even after the closest enquiry and examination by the most expert physician to tell with accuracy the nature, the extent, or the organ affected by the lesion.

It is necessary, therefore, to state the problems confronting the diagnostician in the simplest terms. They are these: A patient who lies prostrate and motionless, who has suddenly been seized by an attack of unsupportable agony within the abdomen, whose abdominal muscles are all inflexibly rigid without sign of movement, and obdurately resistant to pressure, has suffered a disaster which needs the immediate aid of a surgeon. His condition does not enable us to localise the lesion, but merely to assert its existence.

The examination of a patient so grievously afflicted must be brief; motives of humanity no less than of urgent necessity compel us to hasten in decision and to be quick in action. Recent experience appears to shew that the most positive evidence of perforation is derived from an examination by means of x-ray. While the patient's breath is momentarily held a photograph is taken. The presence of a bubble of gas, free in the peritoneum, above the liver is conclusive and the earliest evidence of perforation.

The patient may give a history of former attacks of indigestion, which may lead one to suspect, and even to be confident in diagnosing, an ulcer of the stomach or duodenum. The universal rigidity may appear even more perceptible at the upper part of the abdomen, and one side may seem to be more tender or more resistant than the other.

The fact that fluids escaping from the torn duodenum, or from the pyloric region of the stomach, encounter the little hillock in the transverse mesocolon and are deflected to the right, escaping down the outer side of the ascending colon to the right iliac fossa where some accumulation may occur, accounts for the fact that the localising signs of appendicitis may sometimes be quickly developed. An error in diagnosis was more frequent in the early days of our experience than to-day, but mistakes even now are not unknown. When I collected the first 49 cases of perforated duodenal ulcer,[3] I found that in no fewer than 18 had the diagnosis of appendicitis been made, and an operation performed for this disease. The difficulty in discriminating the most severe forms of perforative appendicitis from cases of rupture of an ulcer is increased by the fact that in the former the first incidence of pain is constantly referred to the epigastrium. An acute attack of pain which begins in the right iliac fossa is, as I have said, rarely due to disease of the appendix, is indeed only due to the appendix when previous attacks of inflammation have affected it.

Acute pancreatitis is often said to present great, indeed insuperable, difficulties in diagnosis. But if the case is carefully studied and examined there need be no hesitation in reaching a definite discrimination between the two conditions. Deaver has said that the chief reason for failure to make a diagnosis of acute pancreatitis is that one does not "think of this disease" at the moment. It is certainly an infrequent condition; the perforation of a duodenal ulcer is common enough; and, therefore, probability being the very guide of life, the perforation of an ulcer is at once in the forefront of one's mind. There is much truth in this; for when the diagnosis of acute pancreatitis is made in a case discussed with others, it is often received with immediate assent. There should, however, not be the least difficulty in making an accurate diagnosis in the earliest stages. Males are affected more frequently than females in the proportion approximately of 2 to 1. Females seem to be more susceptible in the early months of pregnancy. In acute pancreatitis the pain is even more horrible, of more prostrating and overpowering severity than that which follows the bursting of an ulcer. It is, indeed, the most excruciating agony that the human body can suffer, and the very extremity of human endurance is reached. The pain begins in the epigastrium, extends over the whole abdomen, and pierces through to the back, and not seldom to the loins. Shock is present in profound degree from the very first. The patient, often obese, sometimes alcoholic, lies prostate, faint and pallid, the pulse may be hardly perceptible, the limbs and face are cold, and death itself seems imminent. No such state is seen in any other form of casualty. There is all the collapse that even the greatest hæmorrhage could cause, and more than the agony of a visceral rupture. Corroboration of a diagnosis made upon these evidences alone is hardly necessary, but if it were it is never lacking. Vomiting is almost invariably present, and it occurs early. There are cases in which it is repeated with great frequency and severity, so that the resemblance to a case of high intestinal obstruction, in respect of this one symptom only, is very close. The matters ejected are, however, never in the least like those seen when the jejunum is obstructed in its upper part; they are of gastric or of duodenal origin, never foul-smelling and never copious. Nausea and retching with hiccough are more frequent here than in cases where the intestine is blocked. The patient sometimes presents a very curious and, I believe, a quite characteristic appearance, to which Halsted[4] was the first to call attention. The face is livid, and patches of slate-blue colour may be distributed irregularly over the surface of the abdomen, or even of the limbs. This cyanosis is never found in any other form of acute abdominal catastrophe, as far as I know; it is not always present in acute pancreatitis, but if it is found it is, I believe, an undeniable evidence of acute pancreatic disease. Grey Turner[5] has recorded 2 cases in which large patches of discoloration of the skin were attributed to direct action of the pancreatic juice, which by infiltration had reached, in the 1 case the umbilicus, and in the other the costo-vertebral angle. I have seen a faint tinge of jaundice in 5 cases only.

The respirations are quickened in all cases, and are faint and shallow in proportion to the degree of collapse, which is, in turn, dependent upon the degree of swelling in and around the pancreas. An examination of the abdomen makes the diagnosis still more certain. There is a degree of rigidity in the whole abdomen, and the epigastric region is certainly a little firmer than the rest. But the fixity and hardness are not to be compared with the conditions present when a hollow viscus has burst. Then the rigidity is obdurate and unyielding, and immobility of all the abdominal muscles, including the diaphragm, is complete. The lightest handling is then resented. In acute inflammation of the pancreas, however, the rigidity and a degree of tenderness are confined to the parts above the umbilicus, and even in early hours a degree of fulness may be observed here. The whole abdomen is tender, but the tenderness is more acute above the umbilicus than below, and often is far more exquisite to the left of the middle line than to the right, a point not without significance. If the patient survives a few days, as will happen in the less acute cases, the contrast between the upper protruding parts of the abdomen and the emptiness or even retraction of the lower parts may be very striking. This is the condition to which Fitz[6] gave the name "epigastric peritonitis." In the less acute cases there may be time to recognise the urinary changes so often found: glycosuria and a tenfold increase in diastase. Loewe's test is by no means constant, but when present is helpful; 2 or 3 drops of a 1/1000 solution of adrenalin are allowed to run slowly on to the conjunctiva of one eye; after a few minutes the dose is repeated. Within twenty or thirty minutes the pupil of the eye dilates.

The diagnosis of the more acute forms of pancreatitis and their differentiation from the cases of acute perforating ulcer should not be difficult if due regard is paid to the analysis of the symptoms, and if remembrance is given to the possibility of the involvement of the pancreas in cases which are hastily regarded as unduly severe examples of gastric or duodenal perforations.

Acute thoracic diseases may cause the greatest difficulty in diagnosis; no surgeon of large experience is unfamiliar with that close mimicry of an acute abdominal catastrophe which is presented by such disease as acute diaphragmatic pleurisy, acute pneumonia, and acute pericarditis, especially when they occur in young people. These diseases are often ushered in by acute pain which develops quickly, if not suddenly, and the pain, because of the involvement of the lower dorsal nerves which end in the abdominal wall, chiefly affects the parts involved when an ulcer has leaked. In such cases, too, there is often exquisite surface tenderness, and restriction of movement of the abdominal muscles, or even at the first immobility, and a considerable degree of rigidity. All these may appear at a time when the pulmonary or cardiac condition is very slight, or even absent so far as gross physical signs are concerned. Physicians do not perhaps always realise, as the surgeon in the war was made to realise, how great the disproportion may be between the physical signs in the chest, and the conditions revealed when the chest is opened by operation. An early pneumonia or a patch of pleurisy on the diaphragm and lung apposed to it, may be almost impossible, even quite impossible, to discover at a time when the question as to whether or not a surgical calamity has occurred must be discussed. And the decision to be reached may involve the patient's life. For if a perforation of an ulcer is not closed, death will overtake the patient in a day or two; and if an anæsthetic is given when serious thoracic disease is ingeminating the gravest harm may be done. It is only by earnest consideration of certain points that a discrimination may be possible.

(*a*) The examination of the abdomen by the practised hand will disclose the fact that, though tenderness and rigidity are both present, they are not by any means so striking as in cases of perforation. Surface tenderness may be exquisite and a gentle pinching of the skin almost intolerable, yet deep firm, but still gentle pressure will be a comfort to the patient. Neither rigidity nor tenderness are universal; a little relaxation of the abdominal wall may be found in the hypogastrium, or in the iliac regions, especially at the end of each expiration, and here too cutaneous sensitiveness is less acute. Rectal examination discloses no tenderness of the pelvic peritoneum. Indeed, as a rule, a continued observation will be convincing as to the greater implication of the upper as compared with the lower parts of the abdomen.

(*b*) The temperature is nearly always raised, perhaps 2, 3, or 4 degrees in thoracic conditions; it is depressed when an abdominal disaster has recently occurred. In some pulmonary diseases the initial or an early symptom may be rigor, and within a short time the sensitive swollen edge of the lip may indicate that herpes is developing.

(*c*) The respiratory frequency is accelerated out of all proportion to the pulse-rate. There may be 40 respirations or even more to the minute, while the pulse-rate remains near or even below 90. The ratio of pulse to respiration is normally about 40 to 10. If it is 30 or 25 to 10, then the cause usually lies above the diaphragm and not in the abdomen. This change in the ratio is the most significant of all signs, and in all cases the closest regard must be paid to it.

The differential diagnosis between *acute appendicitis* and the perforation of an ulcer may sometimes present difficulty. This is more especially the case toward the end of the period of reaction. The tendency for fluids which escape from the rupture of an ulcer in the duodenum, or in the stomach near the pylorus, is to be deflected by the little hillock in the transverse mesocolon and to flow down the outer side of the ascending colon into the right iliac fossa. That fossa being filled, the fluid runs into the pelvis. As it follows this track it excites a peritoneal response; it is an acrid and irritating fluid, and peritonitis results from its corrosive no less than its bacterial action. The right side of the abdomen will, therefore, be more painful, more tender, more resistant. In the less acute cases, therefore, in the period of reaction, the inflammatory conditions are apt to resemble those of an acute appendicitis with spreading peritonitis. The lymphatic areas of the right side of the abdomen are a part of the plexus, which includes also the vessels of the appendix, and an acute, wide-spreading lymphangitis results when there is an acute inflammation of the appendix falling short of perforation. But both the clinical history and the physical signs should enable an accurate differential diagnosis to be made. In acute appendicitis the onset of pain is never so severe, never overwhelms a patient with its unendurable intensity; it is never quite so sudden, but reaches its greatest height an hour or two, or even more, after the first pangs are noticed. The perforation of an appendix certainly causes a sudden and an exceedingly severe pain, even an agony; but perforation is the consequence of some added factor in an already inflamed appendix which has declared its infection by signs and symptoms which should easily be recognized. The rule, with few exceptions, if any, is that the perforation of an appendix follows the administration of aperients given because of the abdominal discomforts caused by the inflammation of the appendix. Without aperients there is never perforation.

In all cases of acute appendicitis there is an elevation of temperature, slight perhaps and fugitive, but always to be observed if accurate and continuous observation is made. Both vomiting and diarrhœa are common in the early stages. Local tenderness, rigidity, cutaneous hyperæsthesia, and swelling suggesting a phlegmonous inflammation are all likely to be noticed and to make a diagnosis unequivocal. Examination of the rectum reveals tenderness, especially in those cases where the appendix hangs over the brim of the pelvis; and the infection of the pelvic peritoneum causes irritability of the bladder, and pain at the end of micturition, and may lead to an infection of the urine by the Bacillus coli. The leucocyte count is raised.

An attack of *abdominal colic*, biliary, renal, or intestinal, is often believed to present difficulties of differential diagnosis. There should be none. An attack of colic comes with equal suddenness, but it excites not immobility, but agitation and infinite restlessness. A patient struck down by the perforation of an ulcer is motionless; his body is intensely rigid, every slightest active movement is avoided, and every passive movement bitterly resented. Even every act of inspiration is shortened, so as to avoid any slightest abdominal movement. A patient in the agony of colic can find no resting place. He writhes and groans, and moves about or rolls on the bed or floor in search of the comfortable position he never finds. His arms are pressed to his abdomen, and he welcomes the strong pressure of another hand. There is never any universal abdominal rigidity. There is local stiffness, and the abdominal muscles are tightened in the effort of groaning, but there is no slightest evidence of general involuntary rigidity. The picture of the two sufferers is so completely different that it is impossible to suppose that the difficulties in diagnosis can exist for those who have seen the states produced by these two catastrophes.

In biliary colic the pain beginning in the epigastrium veers to the right side and pierces through to the shoulder-blade. The pain comes with instantaneous suddenness, and may leave with equal abruptness. A patient may be rolling in agony in one instant and smiling in happy relief in the next. The change is incredibly swift when the stone is released from the cystic duct.

In renal colic the pain begins in the back, soon is reflected to the front of the abdomen, and shoots to the testis, and to the groin and to the inner and upper part of the thigh. There is often an urgent and frequent ineffective desire to urinate.

Intestinal colics due to foods unsuited to the individual or to ptomaine poisoning are not localised to any part, but rather affect the whole abdomen; there is no localising tenderness or resistance, nor any distinguishing cutaneous hyperæsthesia. Restlessness, the relief from pressure, the absence of tense, inflexible, and universal abdominal rigidity makes the differential diagnosis quite indisputable. Severe lead colic may present more difficulty, as it is the only form of colic in which definite rigidity and tenderness occur over the whole abdomen; the patient lies perfectly still and resents the slightest pressure on his abdomen. A history of contact with lead and a blue line on the gums would suggest the possibility of lead poisoning, but the diagnosis can be rejected with confidence unless examination of a blood film proves the presence of punctate basophilia. This indicates a state of acute lead intoxication, which alone could give rise to a degree of colic sufficient to stimulate an abdominal catastrophe.

There are occasions when *profuse hæmorrhage* associated with severe pain may produce a condition requiring to be distinguished from that of perforation. Of these, the most common and the most serious is concerned with the rupture of a tubal gestation. There is the same sudden onset of acute abdominal pain, the same immediate prostration, the same acute anxiety for the patient's life. Beyond these there is little resemblance. Blood which escapes, sometimes in very large quantities, into the abdominal cavity is little irritating, one is tempted to say in no degree irritating, to the peritoneum. Its entry is not resented, and accordingly does not cause the same extreme response, whether viscero-motor or viscero-sensory, as is made by irritating gastric or intestinal contents. There is, therefore, not the same agonising pain, nor is there the same incoercible abdominal rigidity. This catastrophe occurs, as a rule, after one menstrual period has been missed. A sudden severe pain, not of the same prostrating severity as in rupture of an ulcer, but nevertheless very acute, is noticed almost at the same moment that a vaginal loss of blood occurs. The pain continues, and soon the signs of internal hæmorrhage are observed. These are pallor, faintness, rising pulse-rate, decreasing blood-pressure, air hunger, restlessness, and so forth. The patient's anxious sweating face tells of suffering and apprehension. The abdomen is soft, perhaps a little full and a little doughy, especially in the lower half, and perhaps on one side rather than on the other; the respiratory movement in it, always slight, is unaffected. The history and these physical signs leave, as a rule, no doubt as to the nature of the calamity. Other forms of hæmorrhage, traumatic in origin, do not present any difficulty. "Ballance's sign," the slow change and position of the area of dulness on percussion due to extravasated blood is often clearly elicited.

Various forms of *intestinal obstruction* sometimes cause symptoms not widely diverging from those of perforation. There is the same sudden onset of pain, and the same implication of the whole abdomen in the response; there are vomiting, prostration, slowly advancing distention; there is absolute cessation of voluntary intestinal discharge, of flatus as of fæces. But there is not the same fierce intensity of the symptoms in any form of intestinal obstruction except one, volvulus. And in this, as in all others, the abdominal rigidity does not approach the metal-like fixity and immobility seen in cases of perforation, nor is the pain so agonising. There is in obstruction an immediate onset of vomiting, and this symptom persists and is uncontrollable. Small quantities are ejected frequently, indicating that the stomach is already overdistended, and is continually being filled, no matter how quickly it endeavours to empty itself. The ejected matters are gastric, then duodenal or jejunal, brown, offensive, and bitter. "Fæcal" vomiting is seen only in cases of gastro-colic fistula, or a few moments before the agony of death. The term "fæcal vomiting" indeed should disappear from the vocabulary of intestinal obstruction.

A condition, happily infrequent, which may give for perhaps a few hours at the onset as close a resemblance as any other to acute perforation of the stomach is *mesenteric embolism* or *thrombosis*. There is the same sudden onset of acute intolerable pain: the same prostration, some degree of abdominal rigidity, and a quickly developing distention of the whole abdomen. But the pain soon becomes intermittent, and is spoken of as cramp; blood appears in the stools, sometimes within an hour or two. The patient becomes profoundly collapsed, the pulse-rate rises rapidly, the temperature falls. There is often, though not invariably, an obvious source from which an embolus might be derived, vegetative lesions on the left side of the heart being the commonest. The cases may be divided into two groups: the acute and the chronic.

In the acute cases the symptoms are ushered in with absolute abruptness at a time when the patient is in good health. The patient is, as a rule, of middle age, inclined to obesity, and may present evidences of chronic valvular disease of the heart, or of early arteriosclerosis; an operation may recently have been performed. There is a sudden, intense, abdominal pain, at first colicky in character, later becoming almost unremitting, which is speedily followed by nausea, vomiting, and perhaps collapse. There may be diarrhœa or constipation; if the former the motions are frequent and blood-stained; if the latter obstruction is absolute, neither flatus nor fæces being passed. In both the abdomen becomes distended, rigid, and tender. There are occasionally the signs of free fluid in the peritoneum. The general condition of the patient is poor from the first and rapidly becomes worse. The temperature is often sub-normal. The pulse is always rapid, and its quality is bad. Blood-stained motions are found in 41 per cent. of the cases, but even when no obvious blood has been passed, the intestinal contents are always found to be deeply blood-stained. The second smaller group is formed by cases of quiet, insidious origin, with a prolonged and varying course. Jackson and others have shewn that the belief that the acute cases were dependent upon embolism, and the chronic upon thrombosis is fallacious. In the series of cases collected by Jackson, Porter, and Quinby[7] there were 7 marked chronic cases dependent upon thrombosis and 7 dependent upon embolism.

The cases are almost twice as common in men as in women, and the majority are found between the ages of thirty and sixty years.

There is always the greatest doubt as to the nature of the illness from which the patient suffers. A diagnosis of intestinal obstruction is generally made, and it is only at the operation or at an autopsy that the exact condition of affairs is revealed. A previous history, perhaps a protracted history of gastric discomfort, is sometimes given. It is an evidence no doubt of arterio-sclerosis affecting the vessels within the abdomen. In these cases the mimicry of such organic diseases as gastric or duodenal ulcer, or cholelithiasis may be very accurate. In all cases the greater suffering caused by heavy meals as compared with the less suffering after light meals is most significant.

It is only within an hour or two of the onset of the acute cases that any doubt in diagnosis should exist. And even in this period there is never the same intense and unyielding abdominal rigidity as is invariable in cases of perforation.

There is only one matter remaining for discussion. It concerns the mimicry of these cases of abdominal catastrophe by the "crises" dependent upon tabes dorsalis. No case of abdominal disease, acute or chronic, is adequately examined unless the pupillary reactions and the ankle and knee-jerks are observed. Gastric crises may cause symptoms which are mistakenly attributed to organic diseases of the abdominal viscera;

and such lesions as gastric or duodenal ulcer, cholelithiasis, renal calculus, and appendicitis have all been diagnosed, and operation performed in cases of tabes dorsalis. In a paper, "Gastro-enterostomy and After,"[8] I related cases of these diseases in which this operation was so performed, and every surgeon of large practice in abdominal surgery is perhaps familiar with this most grievous error. On the other hand, cases of ulcer have been diagnosed as suffering from tabes. It is to be remembered that the sensitiveness of the abdominal organs, and the rapidity and acuteness of both the viscero-motor and the viscero-sensory reflexes is less in cases of tabes than in normal individuals. An abdominal catastrophe may occur in a tabetic. The danger of overlooking it, and of ascribing the symptoms to a gastric crisis, is a very real one. I have once been confronted by this difficulty, but happily the symptoms, though reduced in intensity in comparison with those seen in normal individuals, were still so extreme as to necessitate immediate operation.

The conclusion from this discussion is clear. The diagnosis of an abdominal calamity requiring immediate surgical treatment is made when a sudden attack of prostrating and overwhelming agony is associated with an obdurate, unyielding rigidity of an abdominal wall which is everywhere excessively tender and immobile. Shock in the strict surgical meaning is not present. If we wait for it, we are risking the patient's life, for it is not an evidence of perforation, but of the peritonitis which is preventable and should be prevented. We may not be able to say, when these signs alone are present, that the catastrophe is certainly in one viscus, or certainly in another. It matters little where it is, all we need to know is that wherever it is, and whatever it is, it is irremediable except by surgery. We must reduce this matter to simple terms, and that is the only method by which we can succeed. The salvation of a human life is a greater thing than the establishment of a convincing, irrefutable clinical diagnosis.

Operative Treatment.—The technical details in connection with the various operations will be found in other works concerned with the craft of surgery. I propose here to discuss only their applications and results. When a perforation has occurred there are obviously two methods of dealing with the gap in the stomach or duodenum. The opening may be closed, or it may be used for the insertion of a tube. The results of surgery, given adequate competence in the operator, depend almost entirely upon the time that has elapsed after perforation.

If the operation is performed early, and the conditions are favourable the rent in the viscus is closed. If this closure brings about an immediate stenosis, or appears to threaten or ensure stenosis in the future, the question of the performance of a short-circuiting operation will arise. Alternatively the rent in the viscus may be enlarged, the ulcer excised, and the incision so sutured as at once to enlarge the calibre of the viscus at the part implicated.

If the operation is performed late; if it is a rescue operation rather than a reparative operation, then the opening in the base of the ulcer may be used for the introduction of a tube, rapidly fixed in position, and used for days after as a means of introducing fluid food to sustain an almost exhausted or nearly moribund patient. A drain into an overloaded peritoneal cavity is rapidly introduced above the pubes, but time will not allow of more than this.

There is an increasing tendency on the part of most surgeons, I think, to deal, if possible, reparatively with a lesion in the duodenum. The whole ulcer, together with the gap in or near its centre, is excised, and the resulting opening, perhaps of large size, is so sutured that not only is a stenosis avoided, but a larger calibre of the intestine results. These methods are based upon the old "pyloroplasty" introduced by Heineke and Mikulicz, and changed in scope and greatly improved in respect of results by Finney, and finally by C. H. Mayo.

The older methods of simple closure of the ulcer lying near the pylorus, on one side or on the other, were found not seldom to cause a degree of stenosis, which called for a second operation in a few months or in a few years, time. The suggestion that the short-circuiting operation should be performed at the time of closure of the perforation was first urged by me in 1901.[9] Individual experiences vary as to the frequency with which secondary operations are needed; as to the mortality attributable to the added procedure, immediate gastro-enterostomy, and as to the quality of the immediate convalescence of the patient so treated. But the wisest opinions seem to have steadily drifted toward a recognition of the need of some procedure to counteract, or to control stenosis, in a large proportion of cases of duodenal rupture.

When the perforation lies in the stomach the same problem does not arise, unless the ulcer has lain close to the pylorus. If the lesser curvature, or any part of the stomach, away from the pylorus is implicated, then it seems quite certain, from universal experience, that though recurrence of the ulcer may take place, a degree of stenosis calling for relief is extremely rare.

In order to indicate the methods used, and the results which follow, I have asked Mr. W. H. Symons, Assistant

SUMMARY OF ALL CASES OF PERFORATED ULCER (1920–1925, INCLUSIVE) IN WHICH DATA REQUIRED ARE AVAILABLE

PERFORATED GASTRIC ULCER

Operation performed.	Under twelve hours.		Twelve to twenty-four hours.		Over twenty-four hours.	
	Cured.	Died.	Cured.	Died.	Cured.	Died.
Suture only	10	1				
Suture with drainage	3	..	..	1	..	2
Suture with gastro-enterostomy	1					
Suture with gastro-enterostomy and drainage	2					
Suture with jejunostomy	2	2				
Suture with jejunostomy and drainage	..	1	1			
Total for all forms of operation	18	4	1	1	..	2

PERFORATED DUODENAL ULCER

Operation performed.	Under twelve hours.		Twelve to twenty-four hours.		Over twenty-four hours.	
	Cured.	Died.	Cured.	Died.	Cured.	Died.
Drainage only						
Suture	34	9	3	..	1	1
Suture and drainage	9	7	7	10	..	6
Suture and gastro-enterostomy	71	7	4	2	..	
Suture and gastro-enterostomy and drainage	13	3	..	1		
Suture and gastro-duodenostomy and drainage	..	..	..	1		
Excision and pyloroplasty	21	1				
Total for all forms of operation	148	27	14	14	1	7

MORTALITY RATES

	Operation under twelve hours.	Twelve to twenty-four hours.	Over twenty-four hours.	Total.
Perforated gastric ulcers........	18.18%	50%	100.00%	26.92%
Perforated duodenal ulcers......	15.43%	50%	88.88%	23.11%

Surgeon at the Leeds General Infirmary, to prepare the preceding table, which shews the results of six years, continuous work in a large general hospital. The mortality was heaviest in the early years. In the last year the mortality of all cases of perforated duodenal ulcer was 10 per cent.

The cases tabulated were operated upon by various members of the staff and by senior resident officers. Individual surgeons are able to shew more favourable results.

By the courtesy of Mr. Grey Turner, I am able to publish the following tables from his own practice:

PERFORATED GASTRIC AND DUODENAL ULCERS

Excluding localised perforations, incomplete operations, and cases not operated upon. (To end of 1924.)

Number of hours of perforation. In six-hour periods.	Total Number.	Recoveries.	Deaths.	Percentage of Deaths.
Up to 6......................	35	34	1	2.85
7 to 12......................	63	56	7	11.11
13 to 18......................	20	16	4	20
19 to 24......................	15	10	5	33.33
Over 24......................	14	8	6	42.85
Grand total................	147	124	23	15.64

All cases operated upon within twelve hours. Total 98, with 8 deaths—8.16 per cent.

The conclusions, therefore, may be drawn:

1. In gastric ulcers affecting the stomach, in parts other than the pyloric antrum, the closure of the perforation is all that is required. If the patient is in a later stage of the catastrophe, or if the gap is inordinately large, the opening in the stomach may be used for the introduction of a tube, that is, the performance of a temporary gastrostomy.

2. In duodenal ulcers, where the rent is small and surrounding induration absent or of very limited extent, closure of the perforation is all that is required.

3. In duodenal ulcer where the rent is larger and induration more extensive, one of two courses may be followed:

   (*a*) The ulcer may be infolded and gastro-enterostomy or gastro-duodenostomy performed.

   (*b*) The rent may be enlarged, the ulcer excised, and a plastic operation which secures an enlargement of the passage from the stomach may be performed.

4. In duodenal ulcer where the gap is very large and induration excessive, one of two courses may be followed:

   (*a*) The ulcer may be closed as much as possible, and the gap filled by a plug of omentum, gastro-enterostomy being performed.

   (*b*) The opening may be used for the performance of temporary duodenostomy.

The two methods are both unsatisfactory, and are only to be used in the last stage of the emergency.

The questions of irrigation and of drainage are decided by the extent and quality of the peritoneal contamination or infection.

Complications.—Various complications may follow the operation performed, and may indeed prove to be the most serious factor of the illness. They are more prone to follow late rather than early operations; but no operations, however early, however skilfully performed, by whatever method, are exempt. A review of our cases over many years shews that approximately one operation in six will suffer from some embarrassing sequel, which may involve a very protracted convalescence, or be responsible for the death of the patient at a date remote from the original catastrophe. Grey Turner's experience coincides with our own. In 147 cases he found 23 in which serious complications developed.

1. *Subphrenic Abscess.*—This is perhaps the most serious of all. It is due to an extension of the contamination and infection which spread from the site of perforation in consequence of the extravasation of the contents of the stomach or duodenum. It is slightly more common on the left side in cases of gastric ulcer, on the right side in cases of duodenal ulcer, but each variety of ulcer may cause an abscess upon either side. The evidences of its development do not, as a rule, begin until after the fifth day; by the tenth day they are usually definite. From this time their severity increases rapidly unless relief is given.

2. *Residual Abscess.*—The material extravasated from the ulcer, together with the fluid poured out freely from the peritoneum, may collect in small or large amounts in various parts of the abdominal cavity. In consequence of adhesions which so quickly form, some fluid may be shut off, increase in quantity, and because of the infection rarely virulent, but never absent, result in the formation of an abscess. Gravity decides that the pelvis shall be most frequently the site of such a collection; if the pa-

tient has lain supine, one or other, or both renal pouches may be filled, or the iliac fossa, generally on the right side, may hold an abscess which closely resembles that arising from a diseased appendix.

The signs which result depend therefore upon the position taken by the collection of fluid. If the pelvis is filled, a swelling recognised most easily, and in an earlier stage, by rectal examination will develop. An absence of mucus in the stools for a few days is the signal that proctitis is present, and the rectum must then be examined. The finger impinges upon a tense, doughy swelling, which feels as though a tennis-ball were impacted deep in the pelvis. Day by day this bulging of the anterior wall of the rectum will increase, and if there is no urgency may be allowed to increase until it is evident that a quite definitely circumscribed abscess is present. Then a small opening made by one thrust of the sharp end of a pair of scissors will open the abscess, and its contents will soon drain away. Rectal drainage is far preferable to abdominal drainage, and is effected more easily than vaginal drainage. If the abscess is to develop in one of the other sites a doughy swelling will form, become firmer by degrees, more sharply delimited, and shew the clear evidences of a pointing abscess.

The symptoms are the same in all cases: a little pain localised in the affected area, a little fever, an absence of the progress that the patient may be expected to make at this stage, as shewn by languor, continuing prostration, quick weariness after slight effort, lack of desire for food, furred tongue, and the like. Our suspicions are perhaps aroused, and some anxiety created, before we are able to recognise exactly where the complication is about to develop. We must then examine by routine the chest, the abdomen, the flanks, the rectum, until our fears are confirmed, or happily shewn to be groundless.

3. *Parotitis* is among the most serious of all the complications which may follow after this operation. We now recognise that it is due to an infection extending up Stenson's duct, from a mouth which has not been kept clean. In the early days after an operation of this kind it may be inadvisable to give food. This is perhaps more likely to be the case if the perforation has merely been closed, without the performance of gastro-enterostomy or of gastro-duodenostomy. After these operations fluid food may be given freely and at once, and semisolid food in a few days' time. If these operations have not been performed, there may be a fear of the suture line giving way if even fluid foods are given. Not the least convincing of the arguments urged in favour of the short-circuiting operations is that the convalescence afterward is both safer and quicker, and that such a complication as parotitis is less likely to occur. The prevention of parotitis is a question of careful nursing. It is a tedious matter no doubt to have to attend hourly to the toilet of a patient's mouth, clearing away impurities and lodgements, and keeping the mucous membrane moist. But it must be done. The patient must help by flushing the mouth almost incessantly with some agreeable, fragrant, slightly antiseptic fluid, and he may keep his saliva flowing by the use of chewing gum. A dry mouth is not always a discomfort, it is a real danger.

4. *Pulmonary complications* are of many kinds. Diaphragmatic pleurisy, empyema, basal pneumonia, and pulmonary embolism have all been observed. Infection spreading through the diaphragm is responsible in some cases, and inhalation of vomited material during the op-

eration in others. The emboli which lodge in the lung are derived sometimes from the larger abdominal veins, the internal or the external, or the common iliac (never of course from the veins of the portal system), in which cases, as a rule, death occurs with great rapidity and the pulmonary artery is found completely blocked; or from the small vessels in the anterior abdominal wall, in which case there is an infarct in the lung. A sharp and sudden attack of pain is due to a local consolidation of the lung with a pleuritis over its surface, and there is a cough with a characteristic blood-stained sputum. A series of emboli following each other at a few days interval may occur. There is rarely, however, any anxiety as to the patient's recovery.

5. *Gastric* or *duodenal fistula* may follow the giving way of the suture which has temporarily closed the base of the ulcer, or may be due to leakage occurring after removal of the tube inserted into the stomach or duodenum through the rent. It is always an extremely serious complication, and in duodenal cases is almost invariably fatal. When the stomach is involved a reparative operation may succeed. If the duodenum is involved, it will probably be necessary to close the pylorus and to perform gastro-enterostomy.

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* In honour of Professor Raffaele Bastianelli.

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RELATION OF ABERRANT MENTAL STATES TO ORGANIC DISEASE*

In the month of April we celebrated the centenary of Lister, and in a week of devotion to his illustrious memory we recalled the incomparable services rendered by him to the cause of humanity. We heard once again from the lips of men representing all the civilized countries, each of them a spokesman of high distinction, that Lister, by his researches, had changed the whole scope and practice of surgery. So long as men shall live and suffer, to be rescued from their suffering by the art of the surgeon, so long must the hand of Lister be there to heal them; for the principles laid down by the master are eternal.

Among the multitude of voices which bore eloquent testimony to the immortal labours of Lister, there was one only which witnessed to the truth that the scope of his doctrine spread beyond the bounds of surgery, and must be held to include the whole province of medicine, including research.

The bent of Lister's mind toward biology was soon observed. Many of his early experiments seemed to have little direct bearing upon the craft of the surgeon. Yet he had derived from John Hunter the belief that the beginning of surgery is a knowledge of inflammation; and in studying this process he was making his mind ready for the new observations and deductions which Pasteur was soon to make plain to the world. Pasteur's work had been published some years before, and had been accessible to all. When Lister was handed Pasteur's original paper by the professor of chemistry at Glasgow, he alone of all who read it was able to realize at once the direct relevance of this new doctrine, derided and denied by high authority, to the science and practice of surgery. It is as clear an illustration as was ever given of the need which lies upon us all to keep our minds open to new truths, expectant of them, competent to test and to apply them. Such truths may be born, will, in fact, in the near future almost certainly be born, in the minds of those not directly engaged in the service of surgery.

We speak of Lister's work in its relation to surgery, and rightly attribute to him the almost incredible changes which have come over our own art. But the eternal principles established by Lister have an effect upon all branches of medicine. And it may truthfully be claimed that the adventures of the surgeon have confirmed and illustrated the truth which we owe to William Hunter alone—that infection plays a large part, often indeed the chief or the only part, in the inauguration of many of the diseases still within the province of the physician or the alienist. The thesis developed by him in a series of papers which display both remarkable originality of thought and careful and patient observation, concerns the part played by slight and continuously overlooked forms of sepsis in causing distant and apparently unconnected disorders, often serious and disabling, and not seldom, in their full career, the cause of death. For over twenty years William Hunter pursued his way and preached his doctrine, unregarded, discredited, or denied. For years he was a voice crying in the wilderness. There was once a voice crying in the wilderness which changed the face of the world, and built the world anew on foundations which can never be shaken. William Hunter's contribution to direct research is, in my judgment, the most significant of any conducted in the last generation. Of the truth of his teaching there is not the slightest doubt. Thanks to him, we recognize now the grave importance, the causal significance of small and often concealed areas of septic infection—in the tonsil, the pharynx, the nasal sinuses, the prostate, the cervix uteri, the appendix, the uterine appendages, the gall bladder, and other organs. Hunter's earlier conclusions had reference to the graver forms of anæmia, and he was the first to point out the causative associations of oral sepsis with pernicious anæmia. We are now learning the full truth of his work. We are quick to recognize the dependence of anæmia, of glandular diseases, of certain obscure fevers, of various forms of "rheumatic" affections, of gastric and intestinal disorders, of severe affections of the kidney, and of many affections of the nervous system—from neuritis to functional nervous and mental diseases—of perhaps all forms of cardiac diseases, upon "focal sepsis." In the days before Lister, so my teachers told me, the surgeon would look with apprehension for a blush around a recent wound, and would lay his fingers upon the sterno-clavicular articulation to discover whether the joint was tender. Pyæmia, which laid waste the joints of the limbs in a riot of rapid disorganization, was the most dreaded of all the consequences of wound infection. It was not infrequent for the sterno-clavicular articulation to be the first of all the joints to be affected. Rheumatoid arthritis is pyæmia moving slowly.

My acquaintance with the mental disorders consequent upon infection is not enough to entitle me to speak with an authority in the least degree comparable with that of the distinguished alienists who will contribute to this discussion. But no one who has been attracted to the study of the mind's working in health (if we may for the moment assume the existence of such a state) and in disease can have failed to notice the close relationship of aberrant mental states to organic diseases, especially to those owning an infective origin.

My own attention was first attracted to this subject many years ago, when gastric surgery was in its early days. It was no uncommon experience then to operate upon patients who had for many years lain under the accusation of being "neurotic." For long periods of time they had complained of pain after food; they had in consequence reduced the amount of food taken, restricting themselves to a diet the ingredients of which were readily absorbed or easily propelled; they were often wasted, querulous, ill-tempered, hard to live with; and their social reactions were not improved by the repeated denial of the reality of their sufferings. Yet when an operation was performed, an advanced condition of organic disease of the stomach, for example, was discovered, and by degrees it became realized that the patients had good cause for the complaints which they made. The existence of organic disease in those called "neurasthenic" was often so certain, though obscure, that I endeavoured to impress upon students that the literal translation of the word "neurosis" was "I don't know." Neurosis was the word which covered (and still covers?) a great deal of ignorance. This experience does not indicate merely a mistake in diagnosis by a succession of observers. For the state of the patients fully justified their inclusion among a group of victims of functional psychoses. The point is rather that continuous physical illness, infective in origin, leading to gross organic disease, long unrecognized, has produced a real mental disorder which was regarded as primary, and therefore unrelated to any physical change. The difficulty was, and is, to discover in such patients the focus of infection, or its sequels, which might be the cause of the psychosis.

We are not entitled to make a diagnosis of "neurosis" until we are completely satisfied that, as far as our means of investigation permit, no organic disease is present. When we remember that, in respect of the abdominal viscera, though there is little more to learn of their structural diseases, there is little yet learnt of their functional disorders, we may still be merciful and reluctant in our use of the word "neurosis." The physiologists, owing to their concern with mice rather than with men, have not kept pace with the surgeon in his advancing knowledge of the normal and disordered function of the abdominal viscera. Though an organ may appear to the naked eye to be normal in position and in structure, we cannot be sure that its functions are unimpaired, or that its relations with other organs have suffered no change. When the physiologist works as long in the wards and in the operation theatres as in the laboratory, we may hope to fill up some of the many considerable gaps in our knowledge of functional anatomy.

Each generation of students in medicine, as in other sciences, has to make its own experience. Positive knowledge we may derive from the store created by our intellectual ancestors, but the application of this knowledge, the proof of it, lies with ourselves. In our purposeful testing of truth we are prone to error. Experience is the name we give to our mistakes. After I had learnt by experience of this plain association of disordered mental conditions, of "functional psychoses," with visceral disease I discovered that a century ago the same views had been held and taught by Abernethy in this country, and by Pinel in France. Chalmers Watson,[1] himself a pioneer in this branch of inquiry, quotes Pinel as saying, in 1809:

> "It seems that the primitive seat of insanity generally is the region of the stomach and intestines, and it is from that centre that the disorder of intelligence propagates itself as by a species of irradiation."

That functional psychoses may be dependent upon minute changes in structure in the brain is indicated by the work of Cotton, who describes a "fatty degeneration of cortical nerve cells." In treating these patients, he holds that we are dealing not only with a disorder of the mind, but with a structural disease of brain tissue.

The experiences to which I have referred accumulated slowly. Their general effect was to make me less reluctant to consider surgical treatment for obvious organic disease in those suffering from grave forms of mental disorder. About fifteen years ago I was consulted by a medical man who, in childhood, had suffered many times from appendicitis, and in adult life had been attacked by hepatic colic, lately accompanied by jaundice, rigors, and wasting. It was clear that there was an obstruction of the common bile duct by a stone, that there was a degree of chronic pancreatitis, and that these were possibly linked up with the disease of the appendix, which had affected him in earlier years. But the doctor was "insane"; his form of insanity was of the kind now described as "manic depressive." The effect of a major abdominal operation upon a man with a grave mental disorder had to be considered. I have a useful ready rule, that "it is unwise to allow a patient to suffer or to die from one disease remediable by surgery because he happens to have another." The patient accepted operation, made the usual recovery, and, in his own words, a "cloud was lifted from his brain." He has been at work, except for holidays a little longer than I feel able to take, ever since, and has had no breakdown in mental health. In all I have operated upon 4 cases of this form of insanity, and in 3 the improvement in mental health has been considerable. The fourth was certainly not improved, and though there are longer intervals of apparent normality the "attacks" are as grave as ever. A good deal depends, no doubt, upon the stage at which such patients are seen. The surgeon has very properly been reluctant to undertake any surgical adventure if there are grave adverse circumstances. He has not always realized that such circumstances may perhaps afford more compelling reasons than any for early surgical relief. Now that it appears probable that certain mental disorders are directly dependent upon distant organic diseases, often infective in origin, the removal of those likely causes must be undertaken without misgiving.

In the case of a distinguished medical man upon whom I operated for chronic appendicitis and gastric ulcer, outbreaks of mental disorder had necessitated his seclusion for two long periods. At the time I was consulted about him grave questions were raised as to his mental state and as to the effect of the ordeal of an operation upon him. He contemplated operation with almost a frenzy of fear and horror. My opinion that operation should be delayed only until the advanced dental infection was removed seemed calculated to have disastrous consequences upon the patient and to be a source of deep anxiety to his relatives. All ended happily, however. The usual routine of my abdominal cases was followed: the oral sepsis was first eradicated (this, I insist, must be done, and any other infection treated), the diseased appendix was removed, and partial gastrectomy was performed. Since the operation, now a few years ago, there has been unimpaired mental clarity and strength.

It is interesting to observe that a few of the "insane" patients upon whom I have operated have been members of my own profession. All the attributes of mind and character embraced in the word "insanity" should find a high expression in the doctor. The results of operations upon which mental no less than physical health depends are submitted to a sterner test than usual. The after-history of my cases bears eloquent witness to the value of Hunter's work.

That focal infections, with the organic diseases which they may originate, are capable of causing serious mental disturbance is, I suppose, no longer a matter of doubt. But certain aspects of the problem require careful investigation. We wish to know the frequency of "septic psychosis," of mental disorder due solely to septic infection. We seek to discover the degree of contributory influence exerted by sepsis upon mental aberrations which are primarily psychogenic. What influence has focal infection upon those whose heredity involves them in neuropathic or psychopathic tendencies; or upon those suffering the stormy crises of adolescence, or passing tranquilly through the lethargic involutions of senescence; or upon those who suffer the physiological excitement of child-bearing and lactation? In all these infection, no doubt, finds easy victims. We desire to learn also something of the peculiar circumstances in which a very prevalent disorder, oral sepsis, is sometimes able to exert the gravest influence, and at other times seems inert even though present in an advanced stage. In this the whole question of immunity, in which both Hunter and Lister were interested, is engaged.

Focal infection is certainly free to cause the most serious effects at a distance, while arousing no suspicion as to its existence. The distant and apparently unconnected diseases may arise, progress, and prove fatal without a sign of local disturbance. This cryptic quality is the source not only of danger but of disbelief. It seems at first hearing quite incredible that results so grave and so formidable could be the direct consequences of causes so trivial and remote. But that they are is now beyond the region of dispute.

The organisms responsible in the occult infections are almost always streptococcal. Numbers of them are described, and to the variants descriptive titles are given. The cultural characteristics as tested in the laboratory are classified. Some day it will be generally recognized that the human body, variously constituted, is a fertile culture medium, and that organisms may also be classified according to their choice of a specific human soil in which to grow. Rosenow[2] speaks of the elective localization of micro-organisms, and this may be decided by qualities of soil no less than of germs.

So far as my own work is concerned the infective agencies which appear to be sometimes associated with mental disease are in the teeth, the facial sinuses, the alimentary tract, and the gall-bladder. We know, I think, that these infections are often connected with one another, that oral sepsis may, and often does, precede organic disease in the stomach; that infections of the appendix lead to diseases of the gall-bladder and pancreas; and that infections, wherever arising, are apt when they reach the cæcum and ascending colon to remain there, long after the primary focus has ceased to be active. It would appear that, among the many causative agencies producing diseases of the mind, infection may assuredly be counted as one. Other factors are obviously at work also, and by comparison with them infection may take a subordinate place. My work shows at least this—that mental instability and "insanity" may sometimes be relieved, and apparently permanently removed, by eradication of a focus of infection, or removal of the diseases it has originated. I have seen more than enough to convince me that the doctrines of Lister applied, not only to surgery, but as by William Hunter to general medicine, may find a very fruitful application in the investigation and treatment of cases of mental disease. The work of Cotton and Draper in New York, of Hall in Vancouver, and of Graves in this country seems to set us a new standard of inquiry in this branch of medicine, and to show that no mental hospital will in future be considered as adequately equipped unless it has an x-ray laboratory, a skilled bacteriologist, and can command the services of an enlightened surgeon.

* A paper read in a discussion on Chronic Sepsis as a Cause of Mental Disorder, in the Section of Mental Diseases at the Annual Meeting of the British Medical Association, Edinburgh, 1927. Reprinted from the *British Medical Journal*, 1927, ii, 815.

REFERENCE

[1] Chalmers Watson: *Jour. Med. Sci.*, 1923, lxix, 52.

[2] Rosenow: *Collected Papers of the Mayo Clinic*, 1916, viii, 222.

ACUTE PANCREATITIS*

ACUTE pancreatitis is the most terrible of all the calamities that occur in connection with the abdominal viscera. The suddenness of its onset, the illimitable agony which accompanies it, and the mortality attendant upon it, all render it the most formidable of catastrophes. The disease (in accordance with the classification suggested by Fitz,† of Boston, one of the greatest of physicians, who first described it in the year 1889) is generally said to be of three types—hemorrhagic, gangrenous, and suppurative. The three types differ only in degree. In the most acute form of all, which is rapidly fatal unless an early operation is performed, hemorrhage is found throughout the whole gland. In a less acute form the patient may survive to discharge sloughs of the pancreas, and of the necrosed fat around the pancreas, for many weeks after operation; in a still more chronic form, an abscess in and around the gland may form so slowly that there is time for it to point in front, or in the costovertebral angle. The essential nature of the disease is the same in all three forms. Of the cause of the disease we are at present ignorant insofar as the great majority of the cases are concerned.

Symptoms.—It is generally stated, even by the most competent authorities, that acute pancreatitis is a disease difficult to recognize; that the diagnosis will often be made only when the abdomen is opened, and a blood-stained effusion escapes, or areas of fat necrosis in the parietes, or in the omentum, are discovered. I cannot agree with such opinions. The clinical picture presented by a case of acute pancreatitis is quite unmistakable. It is because the surgeon omits to think of this disease that its presence escapes him. As Deaver says: "Unless a surgeon has seen previously 2 or 3 cases of acute pancreatitis, or unless he keeps the condition constantly in mind, it is seldom that a correct diagnosis is made before opening the abdomen." So many forms of abdominal disaster are seen, and among them so few involve the pancreas, that thought of this organ slips from the memory. I have found in not a few instances, that the moment the diagnosis is suggested, it meets with eager acquiescence. The first and chiefest symptom is pain; and of all the pains that the human body can suffer, this is by far the worst. Even the agony caused by the perforation of a gastric or duodenal ulcer is less than that in acute pancreatitis. The pain, too, is remarkable in that it comes so frequently after a good meal, and for the area of its distribution; it is of fiercest intensity in the epigastrium, but it is felt also in the back and often in both loins. Pain in the back is rare after the perforation of an ulcer, even of an ulcer eroding the pancreas, and perforation of such an ulcer is of far rarer occurrence than acute inflammation of the pancreas. The pain is so intense that it causes profound collapse, in which the pulse rises rapidly and loses volume, and the blood-pressure falls. Almost every writer upon the subject of perforation of ulcers of the stomach or duodenum speaks of "shock." It is true that the patients look profoundly ill, having white and anxious faces; but the pulse in these cases remains almost unchanged in frequency and in volume, and the blood-pressure is little altered. It cannot, therefore, be quite accurate to speak of "shock" as a symptom of perforation, for the conditions inseparable from shock are in this case absent. The collapse of the patient is evident enough, and such a state exists as to render any operation of a far greater severity than normally attaches to it. Of the existence of "shock" in acute pancreatitis there is never the slightest doubt. The patient is prostrate, faint, and pallid; the pulse may be hardly perceptible; the limbs and face are cold, and death itself seems imminent. No such state is seen in any other form of casualty. There is all the collapse that even the greatest hemorrhage could cause, and more than the agony of a visceral rupture. Corroboration of a diagnosis made upon these evidences alone is hardly necessary; but if it were it is never lacking. Vomiting is almost invariably present, and it occurs early. There are cases in which it is repeated with great frequency and severity, so that the resemblance to a case of high intestinal obstruction, in respect of this one symptom only, is very close. The matters ejected are, however, never in the least like those seen when the jejunum is obstructed in its upper part; they are of gastric or of duodenal origin, never foul-smelling, and never copious. Nausea and retching, with hiccough, are more frequent here than in cases where the intestine is blocked. The patient sometimes presents a very curious and, I believe, a quite characteristic appearance, to which Halsted† was the first to call attention. The face is livid, and patches of a slate-blue colour may be distributed irregularly over the surface of the abdomen, or even of the limbs. This cyanosis is never found in other forms of acute abdominal catastrophe, so far as I know; it is not always present in acute pancreatitis, but if it is found, it is, I believe, an undeniable evidence of acute pancreatic disease. Grey Turner[1] has recorded 2 cases in which large patches of discolouration of the skin were attributed to direct action of the pancreatic juice which by infiltration had reached, in the 1 case the umbilicus, and in the other the costo-vertebral angle. I have seen a faint tinge of jaundice in 5 cases only.

The respirations are quickened in all cases, and are faint and shallow in proportion to the degree of collapse, which is in turn dependent upon the degree of swelling in, and around, the pancreas. An examination of the abdomen makes the diagnosis still more certain. There is a degree of rigidity in the whole abdomen, and the epigastric region is certainly a little firmer than the rest. But the fixity and hardness are not to be compared with the conditions present when a hollow viscus has burst. Then the rigidity is obdurate and unyielding, and immobility of all the abdominal muscles, including the diaphragm, is complete. The lightest handling is then resented. In acute inflammation of the pancreas, however, the rigidity, and a degree of tenderness, are confined to the parts above the umbilicus, and even in early hours a degree of fulness may be observed here. The whole abdomen is tender, but the tenderness is more acute above the umbilicus than below, and often is far more exquisite to the left of the middle line than to the right, a point not without significance. If the patient survives a few days, as will happen in the less acute cases, the contrast between the upper protruding parts of the abdomen, and the emptiness, or even retraction of the lower parts may be very striking. This is the condition to which Fitz† gave the name "epigastric peritonitis."

The symptoms I have now described occur only in the gravest form of pancreatic necrosis. If they are less acute, they indicate a degree of inflammation in which the necrosis and the hemorrhage are less extensive, in which, perhaps, a rupture of the pancreas into the lesser sac (the "perforation of the pancreas" of W. J. Mayo) does not occur. It may be that in some of these cases the invasion of the gland occurs through the duct of Santorini, and that only a part, and that perhaps a small part of the gland is attacked: the fact that some patients give a history of earlier attacks makes this suggestion not unlikely. All the manifestations of the disease are in this case subdued, and the patient may gradually improve for three or four days. Then the temperature begins to rise at night to 102° or 103° F., falling in the morning almost to the normal; vomiting becomes distressing and exhausting, wasting is very evident, and the epigastric fulness gradually increases. A swelling may appear behind, between the last rib and the iliac crest, and additional evidences of pancreatic disease may then be elicited. Of these, "Löwe's test" is of no little value. Two or three drops of a 1/1000 solution of adrenalin are allowed to run slowly on to the conjunctiva of one eye; after a few minutes this dose is repeated. Within fifteen to thirty minutes the pupil of this eye becomes dilated in cases of pancreatic disease, and remains unchanged in cases where disease is absent. Urinary changes may also be noticed. Glycosuria is not infrequent, but its absence means nothing. Diastase, normally present in small quantities only, is increased tenfold, or even more. Cammidge's reaction, in the hands of its inventor, has proved useful, but other observers have not found cause to rely upon it.

The differential diagnosis in cases of acute pancreatitis should present little difficulty. The more acute the case the easier is the recognition. No other catastrophe within the abdomen produces at once such unendurable agony, and so profound a collapse. Intraperitoneal hemorrhage, resulting from a ruptured tubal gestation, causes intense prostration, blanching, loss of volume in the pulse with increase in its rate, but relatively, the pain is almost negligible, and the site of it is different. The abdomen in these cases is fuller below than above. The history of a missed period and perhaps of a little vaginal hemorrhage, at the time of the onset of pain, are incidents suggestive of a catastrophe of this kind.

The perforation of a gastric and of a duodenal ulcer occurs, in the great majority of instances, in patients who have suffered from dyspepsia for years, and have undergone one or more periods of medical treatment for its relief. The pain is very severe, but it does not reach the fierce intensity of that experienced in acute pancreatitis; and "shock" as measured by pulse-rate and volume, and fall of blood-pressure, does not occur. For some years I have given special attention to the appearance and condition of a patient in the early hours after perforation of an ulcer has occurred. The pulse, it is always a surprise to find, is very little changed from the normal. In pancreatitis the pulse is so poor, and so rapid, that it can hardly be counted. The abdominal rigidity in perforation is far more inflexible and widespread, and vomiting does not occur with such frequency. There is no lividity of the face, but rather a pallor with sweating of the brow and temples.

A patient who suffers from hepatic colic is restless, moaning and twisting, changing his position every moment, searching for relief which does not come. He folds his arms across the abdomen and doubles himself over them; he presses the abdomen against the back of a chair, or on the edge of the bed; rests for a few moments and walks about, groaning in agony. A patient who has suffered the perforation of an ulcer is motionless; and in acute pancreatitis is almost so. The history of former attacks of the like kind, of flatulence causing great distress, and possibly of jaundice following upon the pain, may help to make the diagnosis clear.

Acute intestinal obstruction may cause the closest mimicry of the symptoms of pancreatitis. Fitz, in his original paper, spoke of epigastric peritonitis with the symptoms of high intestinal obstruction, as being significant of this disease. The onset of the symptoms, when the intestine is caught and closed, may be acute, but there is nothing of the sudden and overwhelming seizure that is seen in acute pancreatitis; nor is there collapse. Vomiting is projectile, and the ejecta are progressively more and more offensive. General abdominal distention with perhaps a local inflation of an obstructed coil, recognized after a long scrutiny and the gentlest palpation, will be distinguished without difficulty from the appearances of distention above and flatness below, which are so frequent when the pancreas is involved. In acute pancreatitis a local distention of the transverse colon may sometimes be noticed.

I do not know of any case in which the victim of an attack of acute pancreatitis has been regarded as suffering from poisoning. Leriche and Arnaud[2] have suggested that in the fulminating cases of pancreatic apoplexy, when the onset is sudden, the collapse profound, the vomiting severe, and a fatal ending not long delayed, the likeness to the symptoms caused by an acute irritant poisoning may well excite uneasy suspicions in the mind of the medical attendant.

When all the cases that I have seen are reviewed, the truth remains, that it is chiefly because the suspicion of this comparatively infrequent disease does not enter the mind that an accurate diagnosis is not more often made. The symptoms and the signs are clear enough.

The cause of acute pancreatitis cannot always be determined. The close association of the common bile-duct with the head of the pancreas, the relationship of this duct with the canal of Wirsung at their termination in the duodenum, the presence of the sphincter of Oddi at the ampulla of Vater, have all helped to foster a belief in the dependence of pancreatic inflammation upon causes arising in the biliary passages. And further, the frequent association of cholelithiasis with pancreatitis, both acute and chronic, has done much to strengthen this belief.

The common duct is completely embedded in the head of the pancreas in approximately 3 cases in 4; in the remaining case, there is a deep groove in the posterior surface of the head of the gland, to receive the duct on its way to the duodenum. A degree of inflammation sufficient to attack all the walls of the duct will, therefore, inevitably spread to the head of the pancreas; the more acute the inflammation and the longer it continues, the greater will be the change produced in the gland. The termination of the common duct in the duodenum is in relation with the canal of Wirsung. Four different modes of association are found. (1) The two ducts end in a cavity which discharges into the duodenum by a small orifice. (2) The common duct is joined about $\frac{1}{3}$ inch above the duodenum by the duct of the pancreas. (3) The two ducts open separately but close together on the surface of a depression in the duodenum. (4) The two ducts open similarly but on the surface of a papilla in the duodenum. In the first two forms any block below the point where the two ducts come together will convert them into a single channel. In the last two any blockage of one duct has no effect upon the other. A further intimacy between the biliary system and the pancreas exists through the agency of the lymphatic system. Attention was first called to this by Maugeret.[3] It is suggested that in cases of gall-bladder infection, a lymphangitis spreads downward to the common duct, and thence to the pancreas, causing on its way an enlargement of the cystic gland, and of the glands which lie along the duct. The recent work of Braithwaite[4] has shown, that when one lymph-channel is blocked, a retrograde current is set up, and the flow occurs through other channels. A pancreatic lymphangitis may be set up by infective material coming from the gall-bladder, and turned aside from its main direction of flow by a block in the enlarged glands.

In acute pancreatitis, the immediate cause of the gland necrosis is the activation of the pancreatic juice by some agent or other, within the substance of the gland. In normal conditions the trypsinogen of this secretion is converted into trypsin by an enterokinase in the duodenum. A reflux of the activated juice into the gland is physically impossible. An increase of the intra-duodenal pressure to 1000 mm. of water does not overcome the resistance of the ducts. It is impossible by experiment to force back the duodenal contents into the ducts (Archibald[5]). The problem, therefore, is to discover what agency is competent to cause the activation of the pancreatic juice before it leaves the gland.

The first demonstration of the influence of the bile, in this respect, was given by Claude Bernard in 1856. He produced acute necrosis of the pancreas by the injection of bile mixed with sweet oil, into the duct of the pancreas. For many years after this an association between cholelithiasis and acute pancreatitis had occasionally been noticed, but attention was especially directed to this subject in 1901 by Opie, in his work on "Diseases of the Pancreas." On examining the body of a patient of Halsted's, who had died from acute pancreatitis, Opie found that the common duct and the canal of Wirsung ended in a common cavity, a diverticulum, the outlet of which into the duodenum was small; this outlet was completely blocked by a calculus which did not fill the diverticulum. In consequence the ducts became converted into a single channel, and a retrojection of bile into the canal of Wirsung, stained a deep green colour, had occurred. This led Opie, Flexner, and others to study the effect of the experimental injection of bile, bile salts, and chemical irritants of several kinds, into the pancreatic duct. Pancreatitis, strictly comparable to the condition met with in man, was found. In all these experiments the injections were made by a syringe, with a greater pressure than could be produced by any agency during life. Nordmann's experiments[6] appeared to show that two factors were necessary to the production of acute hemorrhagic pancreatitis in the dog, (*a*) stasis of pancreatic juice within the ducts of the gland, (*b*) the access of organisms with, or without, bile to the duct. Polya's[7] experiments demonstrated that typical pancreatic necrosis with hemorrhage, and fat necrosis, causing death rapidly, was most readily produced by the intraductal injection of a strongly active trypsin solution, less constantly by the injection of duodenal contents, or by bile mixed with bacteria, and rarely by the injection of bacteria alone or of the discharges from intestinal fistulæ.

Mann,[8] of the Mayo Clinic, has conducted a series of experiments upon goats. In these animals, the pancreatic duct enters directly into the common duct a few centimeters above the duodenum. A ligature applied to the duct below the entrance of the canal of Wirsung, converts the two ducts into one channel. After such an operation the animals lived sometimes three or four weeks. The pancreas was then deeply stained with bile, and all the ducts of the gland were filled with bile. Acute pancreatitis did not develop. If, however, the common bile-duct was ligatured above the entrance of the pancreatic duct and, through a cannula placed in the lower part of the duct, bile drawn from the goat's gall-bladder was injected into the pancreatic duct, acute hemorrhagic pancreatitis developed and caused death. The pressure of bile in the common duct, he found, was due to three causes: the secretory pressure of the bile, the contractile pressure of the gall-bladder, and the pressure of the abdominal muscles. The secretory pressure of bile was assessed at 350 mm. of bile; the contractile pressure of the gall-bladder at 300 mm. as a maximum, though usually it seemed "of little consequence." The mechanical effect of the abdominal muscles and of the diaphragm produced the most marked changes upon the pressures within the duct. Deep respiratory movements, struggling, retching, and especially vomiting, caused the pressure to reach as much as 1000 mm. of bile. If bile was injected at this pressure, directly into the pancreatic duct, acute pancreatitis did not develop, except in one case where there was fat necrosis of the gland. The difference in the results of injection of bile with a syringe and at the lower pressures seemed to be due to trauma, to the rupture of the small pancreatic ducts, and to infiltration of the gland substance by bile when the syringe with its higher pressure is used.

Mann examined the condition of the common bile-duct and the pancreatic duct in 200 consecutive bodies in the postmortem room, and found that in 40 only was there the condition of the ampulla described in Opie's case. He gave the following table:

Group.	Location of opening of pancreatic duct.	Number of specimens	Percentage.
1.	Separately into duodenum	62	31
2.	Two mm. from the apex of ampulla of Vater	90	45
3.	Three to 10 mm. from the apex of the ampulla of Vater	40	20
4.	Duct absent or reduced to fibrous cord	8	4
	Total	200	

Archibald has suggested that the mechanism by which the two ducts are converted into one may be the sphincter of Oddi. This muscle, described by Oddi,[9] had escaped the notice of all surgeons until Archibald called their attention to it. The following brief account of Oddi's work is given by Archibald[5]:

"Oddi studied this muscle both physiologically and anatomically. In brief, he found that the sphincter in dogs was able to resist a pressure of 50 mm. mercury, which equals about 675 mm. of water. He demonstrated in microscopical sections, that the sphincter was composed of a special bundle of circular fibers. He found that the common duct, outside its course through the bowel wall, possesses no muscular fibers. From the physiological side, he discovered that this sphincter could be put into spasm by a mechanical irritation of the duodenal mucosa, or by the application of dilute hydrochloric acid in either the duodenum or the stomach; and that even mere cutting of the bowel to expose the papilla would cause spasms lasting from twenty to thirty seconds. Stimulation of the vagus apparently provoked a very prompt and intense contraction of the sphincter. A like result was obtained by stimulating the central end of the cut sciatic, while stimulation of the splanchnics had no effect. He also observed dilatation of all the extrahepatic ducts in dogs deprived of their gall-bladder. He thought a catarrhal condition in the duodenum was a stimulus to the sphincter, and that this might explain some cases of icterus where other causes could not be found."

After a series of experiments, Archibald concluded that the lesions indicating the existence of an acute pancreatitis were brought about entirely through the action of the sphincter of Oddi, combined usually, but not always, with some increase in pressure in the biliary system behind the sphincter. The effect of the bile, or of its salts, is to cause a cytolytic effect, a direct disintegrating effect, upon the cells of the pancreas (Bradley and Taylor[10]). This work of Archibald encouraged Mann to undertake a further series of investigations upon the anatomy of the sphincter in man. It is evident that if the sphincter is to be able to convert the two ducts into one channel, it must lie distal to the entrance of both the ducts into the ampulla: otherwise it would merely compress the lower ends of the two ducts. In most instances Mann found that the position of the muscular fibres was proximal to the termination of the common bile-duct, and that some fibres also passed round the lowest part of the canal of Wirsung. By their contraction, the two ducts would be narrowed. In rare instances, that disposition of the sphincter was found which would close only the outlet of the ampulla and so lead to a free communication between the two ducts.

The conversion of the two ducts into one, by the closure of the outlet from the ampulla into the duodenum, by the action either of the sphincter, or of a stone, seems to be possible only in 4.5 per cent. of the total number of bodies examined (E. S. Judd). The conclusion has therefore been drawn, that the occurrence of acute pancreatitis as a result of the injection of bile into the duct of the pancreas must be "exceedingly small." But may not the conclusion be drawn with greater likelihood, that it is only those patients in whom the anatomical or physiological conditions are favorable, who suffer from acute pancreatitis? Those conditions are present, it is true in only 4.5 per cent. (Judd[11]) of the total number of bodies examined: but is it not possible, indeed probable, that they are present in a large proportion of those patients who suffer from acute pancreatitis? The incidence of this disease is very rare in comparison with many other forms of abdominal catastrophe; its rarity may well be due to the fact that the essential conditions for its development being absent, most people are safe from its attack. The examination into the exact anatomical conditions present in all the fatal cases, can alone answer these questions. The two conditions, which may be considered as almost essential in the development of acute hemorrhagic pancreatitis, appear to me to be (1) an anatomical arrangement of the parts at the termination of the two ducts, which permits of their conversion into one channel by closure of the orifice of the ampulla into the duodenum, and (2) the presence of infected bile, associated or not with cholelithiasis, in the gall-bladder or in the bile-ducts.

The possibility of the duct of Santorini being the only duct or the larger of the two ducts of the pancreas, the duct of Wirsung being absent or very small, must be remembered. This condition is found in 10 per cent. of bodies examined. The duct of Santorini opens directly into the duodenum without any protective mechanism at its termination. The entrance of duodenal contents into the duct may accordingly take place under conditions which would be powerless to effect an entrance to the canal of Wirsung. A case of acute pancreatitis where the necrosis of the gland was limited to the area of the duct of Santorini was recorded by Opie in the first edition of his work. Other cases have since been observed; the area of the necrosis of the gland being large or small, in proportion to the extent of the gland which is drained by this duct. Brocq[12] has shown the potency of duodenal contents injected into the ducts in setting up an acute inflammatory condition, with hemorrhage, and he found also that normal bile will produce necrosis of the gland if it is injected during the progress of digestion.

An acute lymphangitis can play little part in the onset of the most acute forms of pancreatitis. The disease is too sudden in onset, its ravages too widespread and too intense for that. The essential quality of the disease is auto-digestion of the pancreas, and that can rapidly occur only through an invasion of its duct.

Treatment.—There can be no doubt that recovery from acute pancreatitis, of all grades, except the most severe, is possible without operation. In a number of cases in which I have operated for stones in the gall-bladder, or in the common duct, very extensive areas of fat necrosis have been found, and the pancreas has been large, infiltrated with blood, and œdema around it has been considerable. In one patient, a medical man, accustomed to the practice of surgery, the diagnosis of acute pancreatitis had been made by himself. He was able to detect an "immense difference" between the ordinary attacks of hepatic colic to which he had long been subject, and the last attack which was "beyond everything," and in which, his partner said, he had nearly died. It is, however, equally certain that recovery from this disease, apart from operation, is so rare that no case should be left untreated. Not all the operations that have been practised have helped in the recovery of the patient, for a few instances are related in which the abdomen was opened, the diagnosis made, and the wound closed without anything more being done. Recovery in such circumstances would probably have occurred if the patient had been left alone.

The procedure I adopt and advocate consists: (*a*) in the opening of the abdomen by a paramedian incision above the umbilicus; (*b*) the gaining of access to the pancreas sometimes above the stomach, through the gastrohepatic omentum, sometimes below the greater curvature through the gastrocolic omentum, sometimes, though rarely, through the transverse mesocolon, after the omentum has been turned upward; (*c*) the isolation of the pancreas by gauze packing covered by mackintoshes; (*d*) the evacuation of any fluid around the pancreas, by aspiration if the quantity is large; (*e*) incision of the capsule of the pancreas to allow the escape of blood, of fluid, or of sloughs already detached from the pancreas, or resulting from necrosis of large areas of fat; (*f*) adequate drainage through the anterior abdominal wall, a drainage tube being surrounded by gauze so as to create a barrier of lymph around the area as speedily as possible; (*g*) posterior drainage when necessary; (*h*) cholecystotomy (rarely cholecystectomy) if stones are present, or the gall-bladder appears diseased.

The diagnosis is almost invariably made before the operation commences. In the fat of the abdominal wall, areas of fat necrosis may be seen before the peritoneum is opened. As soon as the abdominal cavity is reached blood-stained fluid escapes. Whatever doubts may have been previously felt as to the nature of the disease, they are at once resolved when these two conditions, fat necrosis and sanguineous exudate, are found. In a very large proportion of the cases a great, but local, dilatation of the transverse colon below the pancreas is found. The colon here is not only much larger than either the ascending or the descending colon, but it is congested in appearance, sometimes very deeply congested, or even inflamed. The condition of the pancreas and of the parts around varies very much. In the most severe cases the pancreas is a phlegmon filled with blood, deep purple in colour, looking ready to burst. In the less severe cases, hemorrhage into the gland is only slight and patchy, and a little turbid blood-stained fluid is found either in the lesser sac or behind its posterior layer.

The isolation of the pancreas at this stage is very important. The fluid about the pancreas is extremely toxic, and its escape into the general cavity of the peritoneum, followed by its absorption, might gravely affect the result of the operation. A dread of this result has influenced many surgeons in their refusal to incise the posterior layer of the lesser sac, and the capsule of the pancreas. It is a mistake not to give vent to this exudate; it can be evacuated without any risk, if adequate care is taken, and after all absorption is more likely to take place from the pancreas itself, or from the cellular tissue around it, if this fluid is allowed to remain under great tension. Incision of the pancreas itself need never be made. If the gland feels very œdematous and soggy, the finger may be very gently insinuated into it here and there, so as to make points of escape for retained secretions and blood. Drainage must be free. In a week or ten days after operation a copious discharge of a dirty-looking, turbid, blood-stained fluid with sloughs, large and small, may occur. Displacement of the rectus to the outer side will do something to prevent the development of a hernia subsequently. If a hernia develops it can be repaired; if drainage is not adequate the patient will die.

The question as to what shall be done in respect of the gall-bladder will depend upon two considerations: the general condition of the patient, and the state of the gall-bladder itself. Whatever the condition of the patient may be, if stones are present in the gall-bladder or common duct, a tube should be placed in the gall-bladder, as many stones as possible being removed from them both. The complete emptying of the gall-bladder, or its removal may be left to another day, but a drainage tube in the gall-bladder will allow the escape of bile and prevent any great pressure within the ducts. If the patient's condition permits it, complete evacuation of the stones should be possible; or, in the most favorable circumstances, cholecystectomy may be considered safe. The margin of safety must not be overstepped. The surgeon is operating to save a life in jeopardy; not to cure his patient of cholelithiasis. If the patient is very ill, and very stout, having a gall-bladder shrunken and fibrotic, buried in adhesions and inaccessible, it is safer to leave matters alone. Archibald, of Montreal, whose work on pancreatitis is characterized by great industry and insight and by much ingenuity in the suggestion of experiments, has advised that the duodenum should be incised, the ampulla of Vater slit open, and the sphincter of Oddi divided, in order to prevent the retention of bile, and its confirmed passage into the duct of Wirsung. I have not used this method in any of my cases, never having found a stone in the ampulla in this disease. The objection to its routine employment is, of course, that it is applying to all patients a method, difficult and time-consuming, which may only be of value in a small proportion of them.

* Reprinted from *Annals of Surgery*, 1925, lxxxi, 132.

† See Essay on "Gastric and Duodenal Perforation," p. 284.

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THE GALL-BLADDER AND ITS INFECTIONS*

THE art of the surgeon which strives to rescue the life or to restore the health of patients, must serve, wherever possible, as the handmaid of science. When, by one device or another, we remove diseased organs, or parts of organs, or alter the mechanical or physiological processes which they fulfil, we may no longer rest content merely with the means by which we effect these changes, we must seek to know by what process the pathological state has been produced, what are its relations, if any, to other morbid conditions, near at hand or far away, and what modulations in function or in action are the result. Surgery does not complete its high mission by healing the individual patient, though this must always be its chief importance. It now seeks to advance the science of medicine, and it may claim to have done so in a manner exclusively its own.

The application of this general principle to the particular instance of cholelithiasis is interesting. Before the surgeon became competent to inspect the gall-bladder little was known of cholelithiasis but its catastrophes. The symptoms caused by stones within the gall-bladder were referred to the stomach, and it was among the description of functional diseases of this organ that the clinical history of the earlier stages of this condition was to be found. In consequence there started the fallacy, which is being so reluctantly abandoned, that gall-stones, as a rule, cause no symptoms, and may often be regarded as "silent" or "innocent." A good account was given by Charcot[1] of the symptoms due to a "floating stone" in the common duct; but he failed to recognise either that a stone was present, or that it was the exciting cause of the various symptoms he enumerated, for he speaks of "intermittent hepatic fever," and was clearly of the opinion that the causative pathological state was to be found in the liver. Much of the pioneer surgical work upon gall-bladder diseases was done in Leeds by McGill, whose dresser I was, and by Mayo Robson, under whom I worked as house surgeon. I recall very clearly the earliest efforts of these two operators. They were concerned merely with emptying the gall-bladder, and did not always succeed even in that; for from time to time stones were afterward discharged from the wound. The gall-bladder was stitched up to the abdominal wall, sometimes to the skin, or deep fascia, usually to the peritoneum. I well remember the considerable adventure of the first operation upon the common bile-duct. And I cannot forget the distress we suffered when, on postmortem examination, stones were discovered in the ducts, after we had failed during operation to recognize their presence.

During the last forty years, in consequence of the knowledge gained during operations, there has steadily grown up a clear understanding of the clinical symptoms caused by cholelithiasis. The various problems of differential diagnosis also have engaged attention, and a conception of the clinical and pathological relations between this disease and other morbid changes within the abdomen has now been established. At the time when groups of symptoms caused by disease in the gall-bladder were found to present certain similarities to groups associated with disease in other organs, the inspection of the parts during operations disclosed the fact that these too were affected by slight or grosser changes. There has resulted a slow recognition of the truth that solitary diseases of an inflammatory character within the abdomen are rare, that in clinical symptoms and in pathological association, alike, there is a relationship between one organ and another. Of this relationship we know little as yet; its existence has, however, clearly been established by direct research, and it is for analogical research to pursue to their birthplace the individual elements in a very complex pattern of pathological changes. Though we have learnt much as to the physiological activities of various organs within the abdomen, we know little of the correlation of normal functions as between one of these organs and another, or between one organ and many others. We know even less of the effect of morbid changes in one organ upon other organs; we are only beginning to realise their existence and their significance.

May I to-day endeavour to interest you in some of the problems regarding the gall-bladder as they present themselves to the surgeon?

Functions of the Gall-bladder

The gall-bladder is not present in all animals. In those who do not possess it the common bile-ducts and hepatic ducts are rather larger, and, as a rule, no sphincter is present at the duodenal ampulla. In man, the removal of the gall-bladder is followed by no perceptible changes in respect of physiological and other processes. The extrahepatic ducts afterwards are always found to be larger than the normal, as they are in those whose shrunken and effete gall-bladder has undergone the "natural cure" of cholelithiasis, described many years ago by Rutherford Morison,[2] and the sphincter of Oddi appears to be thrown permanently out of action.

The earliest opinions attributed to the gall-bladder the function of a reservoir. It is too small for such an office, for it will hold little more than an ounce and a half of bile, the daily excretion of which is approximately 30 ounces. J. B. Murphy regarded it as a controller, or governor, as he called it, of the rate of delivery of bile into the duodenum; and he supposed that an increased demand for bile in the intestine would be met by a rapid discharge of that contained in the gall-bladder. Béla Halpert,[3] however, writes: "The amount of bile, if any, which leaves the gall-bladder through the cystic duct within twenty-four hours is under normal conditions so minimal that the organ can hardly be looked upon as a reservoir with the function of supplying concentrated bile whenever there is a call for such in the intestine."

A considerable amount of controversy has raged round the question as to whether the gall-bladder is capable of contraction. The fact that its walls contain muscular tissue adequately supplied by nerves is surely sufficient answer. I have watched the gall-bladder many hundreds of times during operation, and have never seen anything approaching a tonic or peristaltic contraction. Very rarely one does see evidence of life. The fundus of the gall-bladder or the wall near the fundus may shew a movement that is best described as "wrinkling"; a part of the wall puckers after pressure has for some time been put upon it in order to cause the bile to flow into the duodenum. But this action is slight and transient and incapable of producing any notable effects upon the contents.

Bainbridge and Dale[4] shewed that changes of pressure were found in the gall-bladder which were, in their view, capable of production only by contraction of muscle. Evarts Graham[5] and his assistants, Copher and Kodama, have, however, shewn that if care is taken to avoid intra-abdominal pressure upon the gall-bladder, these "contractions" are not apparent, and, further, that if a rubber bag is substituted for the gall-bladder these periodic "contraction waves" are still recorded; obviously, therefore, they are independent of muscle-fibre. Mann and Higgins[6] made a number of observations upon the emptying of the gall-bladder in different species of animals. In fishes there are no respiratory movements, the abdominal walls are thick, and these authors consider that variations in intra-abdominal pressure, if present, must be very slight. Their observations confirmed Boyden's[7] view that the gall-bladder invariably empties after a rich diet of fat. The conclusions drawn from their work are that:

(1) The gall-bladder empties through the cystic duct. (2) The gall-bladder empties by the contraction of its own intrinsic musculature. (3) The secretory pressure of the liver is of little significance in emptying the vesicle. (4) The intra-abdominal pressure is not a major factor in emptying the vesicle. (5) The sphincter of the common duct is not a factor in emptying the vesicle, except that its relaxation permits the bile to pass to the duodenum under pressure exercised by the contraction of the gall-bladder. I think that these very acute observers have perhaps given too little attention to those considerable variations in intra-abdominal pressure, that must surely result from the rapid body movements by which a fish propels itself. Meltzer[8] formulated a "law of contrary

innervation," which postulates that a relaxation of the sphincter of Oddi is accompanied by contraction of the gall-bladder. Graham believes, however, that emptying of the gall-bladder is a passive rather than an active phenomenon; that in place of the supposed muscular contraction there is rather a "recoil" of the many elastic fibres in the gall-bladder wall in an endeavour to equalise pressure in the gall-bladder and in the common duct after the duodenal sphincter has relaxed. He suggests, too, that the gall-bladder may be "washed out" by the free flow of new bile from the liver, and he attributes some importance to variations of intra-abdominal pressure.

That the musculature of the gall-bladder does exercise activities is shewn by the very occurrence of hepatic colic. Colic is due not to contraction of unstriped muscle-fibre, but to its stretching. Colic cannot occur unless muscle-fibre is present, and if muscle is present it must either act or atrophy.

The multitude of observations made upon the gall-bladder during operations are perhaps not very convincing. The preparation of patients before deliberate operations includes a considerable restriction of diet. The gall-bladder is therefore always full, and no demands are made upon it for delivery of bile into the intestine. It will be interesting to see whether the administration shortly before operation of yolk of egg, cream, and other excitants of biliary flow enables more helpful observations to be made. That which I believe to be the chief function of the gall-bladder, its power of absorption, has long been known to surgeons. For there is abundant experience to shew that when a stone becomes impacted in the cystic duct, and remains there, all trace of bile disappears from the gall-bladder and only mucus remains. This excretory power, recognised by Hammersten[9] has been confirmed experimentally by Rous and McMaster,[10] who shewed that the bile in the gall-bladder was concentrated to one-sixth to one-tenth of its bulk by absorption of fluids carried away by the blood-stream and by lymphatic vessels. This function of the gall-bladder, whether a vital process or due merely to osmosis, when tested by Graham's method, becomes the chief evidence of early cholecystitis. The summary of a very interesting paper by Harer, Harges, and van Meter[11] on the functions of the gall-bladder is as follows:

"1. That the function of the gall-bladder is that of a concentrator of bile, which concentration is effected chiefly by the lymphatics.

"2. That the gall-bladder is emptied of its contents—if it is emptied at all through the cystic duct—by pressure of adjacent, distended, and congested organs during digestion, and by the milking action of the duodenal peristaltic waves, and that the rhythmic contractions of the gall-bladder are of no importance in this respect.

"3. That by means of the lymphatics infections are carried from the gall-bladder to the glands at the head of the pancreas, producing a lymphangitis and a lymphadenitis and a lymph stasis, which later becomes organized and results in chronic pancreatitis."

This last statement is freely made by other writers, but no substantial proof of its accuracy has yet been offered.

It is perhaps significant that the veins of the gall-bladder empty into the portal vein, so that the blood contained in them must pass through the liver. What amount of absorption from the gall-bladder is effected by the free capillary circulation has never yet been estimated. The vascular supply is so abundant that it is no doubt considerable. The fact that the gall-bladder can be removed without any apparent disturbance of the mechanism or results of intestinal digestion suggests that as an accessory to the alimentary canal it is negligible. Its functions are surely concerned, through its power of absorption of the constituents of hepatic bile, with other purposes in the economy of which physiology at present can tell us very little. We may conclude as follows:

1. The chief function of the gall-bladder is excretory.
2. The mucosa of the gall-bladder absorbs fluid and other substances, from the hepatic bile which it reduces to one-sixth or less of its orginal bulk.
3. Fluids and other substances absorbed are carried off by the lymphatics and by the capillary circulation.
4. The mechanism by which the gall-bladder is emptied is complex—muscular contraction, variations in abdominal pressure, milking of the common duct by duodenal peristalsis, the "Sprengel air-pump" action of the bile as it descends from the liver flowing past the opening of the cystic duct, elastic recoil may all play a part in this act.
5. The quantity of bile leaving the gall-bladder in the course of twenty-four hours is very small.
6. The functions of the gall-bladder as an adjuvant of alimentary digestion are slight, and operative experience suggests that they are almost negligible.
7. The part played by the gall-bladder in the general economy by virtue of its powers of absorption is unknown. There is suggestive evidence that it is concerned with the movements or the metabolism of cholesterol.

Infection of the Gall-bladder

Infection of the gall-bladder may be primary or secondary. *Primary* infection is rare. The cause is connected with the solitary cholesterin stone, formed aseptically, as Aschoff[12] asserts, within the gall-bladder. Such a stone is said to own a different origin from all other stones; they are dependent upon infection; this one arises from causes other than infection. When once formed the stone may at length become temporarily or permanently engaged in the cystic duct, whose obstruction starts a primary inflammatory change both in the walls of the gall-bladder and in the contents. The stone by its constant friction against the walls of the gall-bladder may, in this way also, initiate inflammatory changes.

Secondary infections of the gall-bladder are far more frequent. The paths by which infection may reach the gall-bladder are many. Organisms may be carried in the blood-stream, in the bile, in the lymph-stream, or may invade the walls of the viscus by direct extension from neighbouring parts—the liver, the stomach, the duodenum, colon, or kidney.

1. *The Blood-stream.*—(*a*) Arterial route. The gall-bladder derives its blood supply through the cystic arteries from the hepatic artery. The origin of the artery, as Mr. E. R. Flint[13] has shewn, is very variable. Infection is able to reach the gall-bladder by this route only in cases of general septicæmia, and takes the form of capillary embolism.

(*b*) Venous route. The veins of the gall-bladder empty directly into the portal vein. Infection arises through this channel only by a process of thrombosis or thrombo-phlebitis. No example of this has occurred in my series of cases.

We owe our knowledge of hæmatogenous cholecystitis to Rosenow.[14] He found that organisms removed from the gall-bladder, from the bile, from the centre of gall-stones, or from the cystic gland of patients treated by cholecystectomy, contained organisms, chiefly strepto-cocci, which when injected intravenously into animals produced lesions of the gall-bladder, of the bile-ducts, and sometimes of the stomach or duodenum. He suggested that such organisms have an "elective affinity" for tissues like those from which they were taken. Whether it is the micro-organism which selects the tissue in this "elective affinity," or whether it is the soil which alone provides the food necessary for the growth of the germs, the soil selecting the germ, is not a matter of importance. The truth is well established by Rosenow's experiments, and by clinical and pathological research in man, that micro-organisms attacking the gall-bladder may reach it through the blood-stream.

The question has been closely studied in connection with typhoid fever, but the results of experimental work appear very conflicting. J. Koch,[15] in a patient who died of enteric fever, found inflammatory changes in the mucous and submucous layers of the gall-bladder. Just beneath the epithelial layer of the villi he found masses or clumps of organisms, apparently those of typhoid fever. No organisms were found on the surface of the mucosa. He therefore drew the conclusion that it was not from the bile that the gall-bladder was infected, but by a process of embolism. In the nests of organisms in the wall of the gall-bladder propagation took place; liberated organisms escaping through the mucosa into the gall-bladder there to infect the bile. Chiarolanza[16] injected typhoid bacilli into the veins and beneath the skin of rabbits, and described the organisms as forming emboli in the capillaries of the submucous layer of the folds of the gall-bladder.

Other observers have, however, recovered organisms injected into the veins from the bile descending from the liver. It is interesting to know that the injection of Dakin's fluid into the blood-stream is apt to cause acute cholecystitis.

2. *The Lymphatic Route.*—From our knowledge of the development of the gall-bladder we should expect to find few lymphatic communications between it and the liver. In some situations, however, and notably at the

splenic flexure, it seems possible for an organ to appropriate the peritoneal vessels which may come into relation with it. Professor Jamieson tells me that there is great traffic of vessels, especially from the undersurface of the right lobe of the liver with those of the gall-bladder, as together they pass inward on their way to the lesser omentum. Winkerden,[17] investigating the gall-bladder of the cat, failed to demonstrate any communication between its lymphatics and those of the liver. This is a contradiction of Sudler's[18] earlier observations, which shewed an intimate connection between the surface lymphatics of the liver and those of the gall-bladder in man. Dr. A. L. Taylor, examining my cases of cholecystetcomy in which a piece of the liver was removed, found evidence of hepatitis, of a thickened liver capsule, of dilated lymphatics beneath it, and of dilated lymphatics in the outer coat of the gall-bladder.

The "hepato-lymphatic" route of invasion of the gall-bladder, if it exists, would, therefore, appear to depend on the following series of events: hepatitis—infection of intra-hepatic lymphatics—extension of infection to the freely anastomosing surface lymphatics of the liver—involvement of communicating lymph vessels in the outer wall of the gall-bladder. If this sequence is followed then the occurrence of hepatitis should be frequent, and invasion of the serosa and subserosa of the gall-bladder be demonstrable in an early stage of gall-bladder infection. Evarts Graham[19] was the first to suggest the invariable existence of hepatitis in cases of cholecystitis and of cholelithiasis. Many surgeons had been familiar with the fact that infection of the liver, and early and localised cirrhosis, were observed both in cases in which stones were present in the gall-bladder, and in those cases, where although calculi were not found, the gall-bladder shewed evidence of chronic inflammation. Our observations, carried on since Graham indicated the method of enquiry, fully support his contention, and no doubt now remains that hepatitis, if not the invariable, is yet the very frequent antecedent of cholecystitis. A further point concerns the condition of the gall-bladder wall. As to this the answer is unequivocal. The outer coats are in a large proportion of cases more severely affected than the inner. In his series of 81 cases there were only 18 in which inflammatory changes were more marked in the inner coats, and in some of these it was possibly because of the recent addition of more acute changes to the chronic lesion present in the outer coats, the acute changes falling chiefly upon the mucosa because of the temporary impaction of stones in the cystic duct, or the disarrangement of stones arousing infection.

The wall of the gall-bladder contains organisms more frequently than the bile. In 33 out of 81 cases active micro-organisms were found; in 30 cases in the wall, in 25 in the bile. A further observation made in my cases is relevant to this issue. The lymphatic vessels in the outer coat were grossly dilated in 20 cases out of the 81. The vessels were mostly free of cells, but some contained lymphocytes. In 16 of the 20 cases the lymphatics of the subserous coat were dilated.

The lymphatic appears, therefore, to be a very probable route by which infection may reach the gall-bladder. But two further points require consideration. In the first place it is a matter of common knowledge that in gastric and duodenal ulcer there is very frequently a rapid and widespread formation of fibrous tissue in the subserous and serous coats, and this in cases where undoubtedly the infection has its origin in the mucosa. May a similar condition account for the subserous fibrosis in the gall-bladder? I think not, for this reason: that in gastric and duodenal ulcer the infective process rapidly reaches the muscular coat, and the lesion spreads into the outer coat producing reactive fibrosis. But in cholecystitis ulceration of this type is certainly not found, as a rule. On the other hand, the characteristic reaction in the muscular coat takes at first the form of a fibrosis, which tends to strengthen this coat against invasion from the inside. The analogy, therefore, with gastric and duodenal ulcer does not hold good. A second point, however, appears of some importance. In the gall-bladder the continuity of the muscular coat is frequently destroyed by the presence of heterotopic masses of mucosal glandular tissue which dip down through its fibres into the subserous coat. Their presence was demonstrated in 25 cases out of 81. Since, as a usual practice, only one section has been examined from each case, it is probable that this estimate is much below the true one. Most of these heterotopias communicate with the lumen of the gall-bladder, and so provide an easy avenue of infection when once the mucosa becomes inflamed. In these situations, where the normal barrier of the muscularis is absent, the infection can immediately reach the subserous coat and inflammatory reaction takes place here. In 4 cases the glandular inclusions lying in the subserous coat are surrounded by large numbers of inflammatory cells, which are also diffused widely through the coat. The appearance suggests that in these and similar cases an infection starting from the mucosal surface may reach the outer coat without difficulty. It will be seen, therefore, that we cannot definitely rule out the possibility of mucosal infection. At the same time the findings support the view that the hepato-lymphatic route is the one by which infection most commonly reaches the gall-bladder in cases of cholecystitis.

An evidence of the early involvement of the lymphatic system in cases of cholecystitis is afforded by the condition of the cystic gland. C. H. Mayo was the first surgeon to call attention to the significance of this observation. Among the signs which we now accept as indicating early though definite infection of the gall-bladder, proved later on by microscopic and bacteriological examination of its walls, is the enlargement of the gland which lies in close relation to the cystic duct. Indeed, its enlargement not only demonstrates the existence of an infection, but indicates the necessity for removal of the gall-bladder. And the view has also been taken that pancreatic inflammations which are found associated with cholelithiasis are due to a pancreatic lymphangitis. It is difficult to say with certainty how often the pancreas is affected in cases of cholelithiasis. Conditions such as swelling of the head of the pancreas, or hardening, or fibrosis, are very difficult to assess, and mere palpation exposes an opinion based upon it to many errors. My estimate, a conservative one I think, places the frequency of indubitable pancreatic implication in cholelithiasis at 12 per cent. The removal of a tiny portion of the pancreas gives valuable information, but it is not as often practised as it might be. Maugeret[20] was the first to suggest that the free communication of the lymphatics of the gall-bladder and the bile-ducts with those of the pancreas, the whole forming one plexus, explains the origin of pancreatic inflammation secondary to cholecystitis and cholangitis; and she discredits the previously accepted view that the infection travels by way of the cystic and common ducts. Deaver[21] has added the weight of his great authority to this opinion. He writes that, "most cases classed together under the general term of 'chronic pancreatitis' are at first really cases of pancreatic lymphangitis, the infection being propagated from the gall-bladder and bile-ducts, or from the pyloric region of the intestine along their afferent lymph channels, which come into intimate relation with those surrounding and embedded in the head of the pancreas."

We do not, however, know with certainty that there is free communication (if any) between the lymphatic vessels of the gall-bladder and those of the pancreas, or that the infection of the pancreas spreads from its surface inwards rather than from the duct outwards to the body of the gland. Assumptions are here outrunning knowledge.

It is true that in cholecystitis the cystic gland is always enlarged, and that in cholangitis the glands along the duct may be so large and so hard as to make the tactile discrimination between them and stones very difficult. In such cases the supra-pancreatic glands may also be enlarged. Nordmann's[22] experiments seem, however, to controvert the view that invasion of the pancreas is primarily lymphatic. If in the dog a ligature is placed around the opening of the ampulla of Vater into the duodenum, the common bile-duct and the upper duct of the pancreas are then directly continuous one with the other. If, after this ligature, a virulent culture is introduced into the gall-bladder, acute pancreatitis develops. If the same culture is introduced and the cystic duct at once ligatured, no pancreatitis develops. In these experiments, at least, the conveyance of the infection from the gall-bladder to the pancreas is by way of the ducts, and not through the lymphatics. And probably this is often, if not generally, true of the condition in man also. Chamberlain's[23] observations in this connection are especially interesting.

3. *Infection Through the Bile Stream.*—If infection is to reach the gall-bladder through the bile stream, it may either descend from the liver or ascend from the duodenum. That retrograde infection from the intestine is possible is clearly indicated by the presence, as the nucleus of a stone, of foreign bodies which, in the absence of a fistula between the gall-bladder and the intestine, or the surface of the body could reach the lumen of the gall-bladder in no other way. Such a nucleus as a piece of cotton fibre, or a tiny flake of copper from a cooking utensil must ascend from the duodenum. C. J. Bond's[24] experiments lend conclusive support to this view. He found that coloured fluids introduced into the rectum could be recognised in the discharge from the gall-bladder after the operation of cholecystotomy. We know that after the operation of typhlotomy the coloured fluids can be recognised in the intestinal discharge a few minutes after their introduction into the rectum. Bond shewed that retrograde currents extend throughout the entire length of the alimentary canal. What alone is doubtful is therefore the frequency with which this ascending path of infection is followed. The following facts elicited from my cases are relevant. As stated above, in 33 cases out of 81 active infection was present; in 30 cases organisms were cultivated from the wall, in 25 cases from the bile. In 8 cases in this series

the bile was extracted from the duodenum by Lyon's[25] method. In 2 cases only were organisms present which proved identical with those found later in the gall-bladder.

The influence of hypochlorhydria or of achlorhydria is perhaps important. The duodenal contents are usually sterile, and are made and kept so by the antiseptic action of the gastric juice, which depends upon the presence of hydrochloric acid. In over 300 of my cases, including this series, it was found (by Dr. Aileen Wilson) that 22 per cent. of patients shewed complete achlorhydria, the ordinary incidence of the condition being not more than 6 per cent. Achlorhydria, in cases in which afterwards gastro-enterostomy or gastrectomy is done and the mucous membrane examined, is found to be sometimes associated with and is perhaps dependent upon chronic gastritis. We do not know at what period of life achlorhydria first occurs, whether it is a congenital condition, or whether it follows upon some acute or sustained infection in early years. But it appears very probable, and Knott's[26] work would confirm this view, that when free hydrochloric acid is absent the "gastric germicidal barrier" is removed; the pylorus is then relaxed, and organisms escape unharmed into the duodenum, whence (if there is also a relaxation of the sphincter of Oddi, as seems probable), they may ascend to the gall-bladder. It is significant also that achlorhydria is perhaps responsible for lesions of the appendix, which may, through the portal system, themselves be the precursors, or possibly the causes, of an infection of the bile as it descends from the liver. My cases shewed that when achlorhydria was present the bile in the gall-bladder was infected in 66 per cent., as compared with

28 per cent. in the cases where the acid content was normal or increased; the incidence, that is, of biliary infection, is more than twice as high. Judd,[27] in an examination of 100 consecutive cases, found that the gall-bladder wall shewed organisms in 29; in 7 cases only did the bile contain them.

Hyperchlorhydria was present in 16 of my 81 cases, and 6 of these patients had duodenal ulcer as well as cholecystitis. The evidence, therefore, appears to shew that infection of the bile through the duodenum does certainly occur, and that it is more likely to develop when achlorhydria is present. When achlorhydria was found, the radiological examination shewed a pyloric relaxation and a quicker escape of gastric contents into the duodenum. The associated relaxation of the sphincter of Oddi, though possible, is not demonstrable.

Infection may also reach the interior of the gall-bladder through bile descending from the liver. The sequence of events in this "hepato-biliary route" will therefore be: Infection of liver cell—hepatitis—destruction of parenchyma—infection of bile—contact infection of gall-bladder mucosa. If this path were followed, we should expect to find that when a piece of the liver is taken for microscopic examination inflammatory changes are present. In 3 cases in this series a definite hepatitis most marked in the portal tracts was found. The number is too small to have any value greater than this, that it does shew that this type of hepatitis definitely occurs in association with cholecystitis. The infective agent which reaches the gall-bladder in this way is derived from the portal system. In this are two streams: the one derived from the alimentary canal, the other from the spleen. So far as the alimentary stream is concerned the main source of origin is almost certainly the appendix. We know from the clinical experience of a multitude of observers that the appendix shews evidence of disease in a large proportion of cases in which cholecystitis or gastric or duodenal ulcers are present. Indeed, it is rare to find solitary inflammatory affections of the stomach, duodenum, pancreas, liver, gall-bladder, or appendix. When one of these shows evidence of disease, one or more of the others is likely also to be implicated. Whether the disease starts in one and spreads thence to the others, and if so in which one it begins is doubtful. All of these viscera may possibly derive their infection from an outside source. There is a constant stream of bacteria from the intestinal lumen into the blood. The organisms may be arrested in the glands of the mesentery, or in the endothelium of the liver sinuses. So long as they remain within leucocytes no signs of infection arise. The destruction of organisms by the Kupffer cells leads to a filling of the perivascular spaces by leucocytes, and finally to hepatitis. The bactericidal power of the liver is known to be considerable; the hepatic cells are, indeed, formidable "destructors." Some few organisms, by happy chance for them, may from time to time escape with their lives, perhaps at a time when the liver is momentarily overwhelmed by a flood of unusually virulent microbes. Those which so escape descend in the bile to the gall-bladder, and contact with bile may cause the organisms (especially if they are of the Bacillus coli group) to clump in the concentrated bile and so to become the nuclei for stones. If hepatitis is incidentally caused, it by no means necessarily follows that the gall-bladder suffers later, whether through the lymphatics or through the bile-stream; for multiple or solitary abscesses of the liver, or such conditions as syphilitic hepatitis may be very advanced, yet the gall-bladder remains normal.

But remembrance should also be given to the possibility that organisms within the portal current may be derived from the spleen. The association of diseases of the liver, and of gall-stones, with diseases which seem to have their origin or their chief development in the spleen, has recently become clearer. In cases of hæmolytic jaundice, 60 per cent. of the patients suffer also from cholelithiasis. With splenic anæmia, both cirrhosis of the liver and gall-stones are sometimes associated. Enlargement of the spleen is noticed in cases of stones in the gall-bladder and the duct, but sufficient regard has not been paid to the possibility that it is from the spleen that the infective agent is immediately derived. There are cases in which a large number of small stones are found throughout the substance of the liver, not only in cases of cirrhosis, but in cases where the liver appears little, if at all, changed from the normal. And every surgeon is familiar with cases of recurrent gall-stones in which the common duct and all the ducts of the liver within reach are filled with mud and fine stones, which may be washed down in almost unending quantities. In such cases I pass several tubes up into the liver, and apply the Carrel method of irrigation for perhaps many weeks. Splenectomy for recurrent cholelithiasis may be found necessary in such cases. One of the functions of the spleen is to filter out micro-organisms and toxic substances from the blood-stream and to send them to the liver for destruction. It may sometimes harbour them rather than transmit them. Its capacity to do so in syphilis has been shewn by W. J. Mayo. Possibly in other infections micro-organisms or toxic materials are held up and passed on only from time to time to the liver, which in this way receives the material upon which gall-stones are deposited. I think it not unlikely that stones, with a nucleus of bilirubin-calcium, may originate in excessive activity of red-cell destruction by the spleen.

Direct Extension.—Infection may reach the gall-bladder from any viscus to which it adheres. If, for example, a duodenal ulcer or even a gastric ulcer is about to perforate, the gall-bladder may become adherent to the inflamed area; and if the wall of the intestine is then completely destroyed, the gall-bladder wall may form the base of the ulcer, and so prevent perforation. Infection in this way may be spread from the outer coats to the lumen of the gall-bladder. When so close an attachment of duodenum and gall-bladder occurs it almost invariably has its origin in the latter. A stone seeks to escape from the gall-bladder, which becoming inflamed adheres to the duodenum. A fistula forms, and a large stone escapes, perhaps to become impacted in the intestine and to cause acute obstruction. In only one case in my series of 81 did it seem possible that the gall-bladder was infected in this way.

Conclusions.—An examination of the gall-bladder wall in my series of 81 consecutive cases shews clearly that infection began in the outer coats in 63. In 18 cases the inner coats were more seriously affected, but in some at least of these it appears possible that infection, beginning in the outer coats, attacked the inner coats more severely, only because impaction of a stone in the cystic duct caused an obstruction, which was quickly followed by inflammatory changes which fell upon the mucosa first. Infection may reach the outer coat by direct extension from the liver, by lymphatic infection from the liver, or by implication of the peritoneal surface as a consequence of disease in an adjacent organ, such as the appendix. In those cases in which infection begins from within, the ascending route appears to be followed more frequently than had been realised. Cholecystitis seems, as a rule, to be a part only of an infection which has its origin elsewhere; hepatitis is very commonly, if not always, present, and is almost certainly of earlier origin than the inflammation of the gall-bladder.

Pathogenesis of Calculi.—When a gall-bladder containing stones is removed by operation and examined at once with the *x*-ray, a very interesting study is made. As a rule, with few exceptions, the composition of the stone is dependent upon its size. The smaller stones are translucent; they consist of cholesterin without admixture or addition of any other substance. As the stones grew larger a thin deposit of calcium is found upon the surface; the *x*-ray picture shews a thin crescent, the "new moon" appearance, or a smattering of black spots upon a translucent stone. When the stone is still larger a complete covering of calcium is found, and the "wedding ring" stone is seen in the *x*-ray photograph. As the calcium deposit becomes heavier the shadow grows increasingly opaque, and finally a dense black appearance is presented. The inference is clear, I think, that not only the solitary stone but the multiple stones are, as a rule, built around a nucleus of cholesterol crystals deposited from the concentrated bile.

The deposition of calcium undoubtedly occurs more rapidly upon an impacted stone. When, for example, there are a number of cholesterin stones of medium size in the gall-bladder, and one becomes wedged in the opening of the cystic duct, or in a pocket at the fundus,

Fig. 2.—A generation of large translucent pure cholesterin stones.

Fig. 3.—Two small stones with calcium nucleus. Large stone showing layers of calcium and layers of cholesterin.

Figs. 2 to 6 form part of a series of x-ray photographs of the gall-bladder, taken immediately after removal, to show the constitution of stones, by Dr. L. A. Rowden.

Fig. 4.—Cholesterin stones: on the largest one, displaced during operation from the cystic duct, calcium is being deposited.

Fig. 5.—Cholesterin stones with early laminar deposit of calcium.

Fig. 6.—Calculi with calcium nucleus, surrounded by cholesterin.

Fig. 7.—Gall-bladder wall from a typical case of chronic cholecystitis. The mucous membrane is relatively intact and the muscular coat of healthy appearance. The subserous coat is greatly thickened.

Fig. 8.—Peritoneal and subserous coats of a gall-bladder wall in chronic cholecystitis. This shows again the great fibrotic thickening and congestion and the ubiquitous infiltration by chronic inflammatory cells. The large spaces have contained fat. The mucosa and muscularis are almost intact.

Figs. 7 to 12 are photomicrographs by Dr. A. L. Taylor, showing the condition of the gall-bladder in chronic cholecystitis.

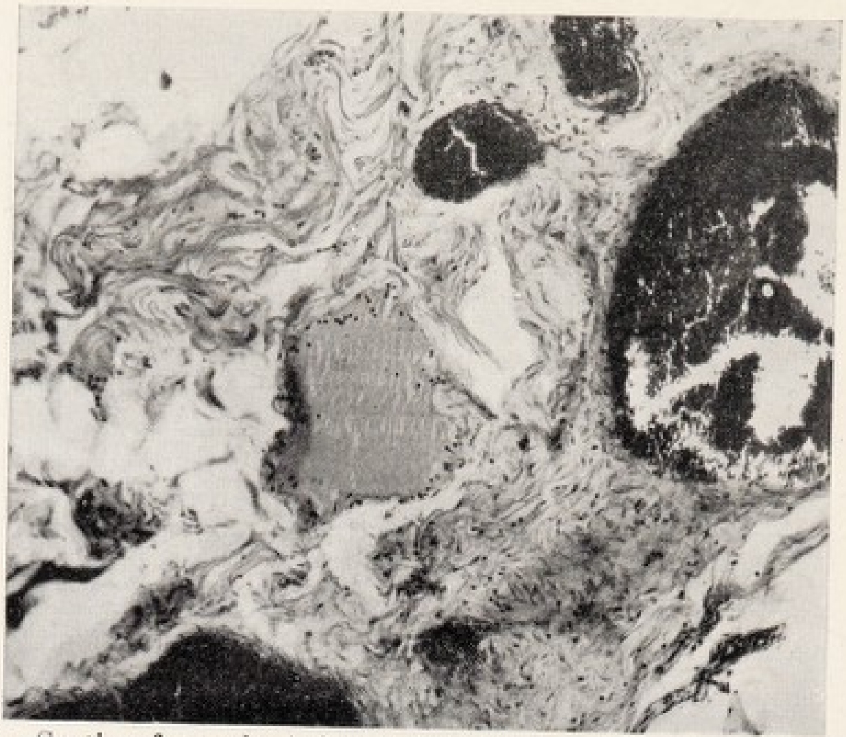

Fig. 9.—Section from the inflammatory fibrous tissue immediately beneath the serous coat. In the middle of the field is a greatly dilated lymphatic vessel. The mucous membrane in this case is practically normal.

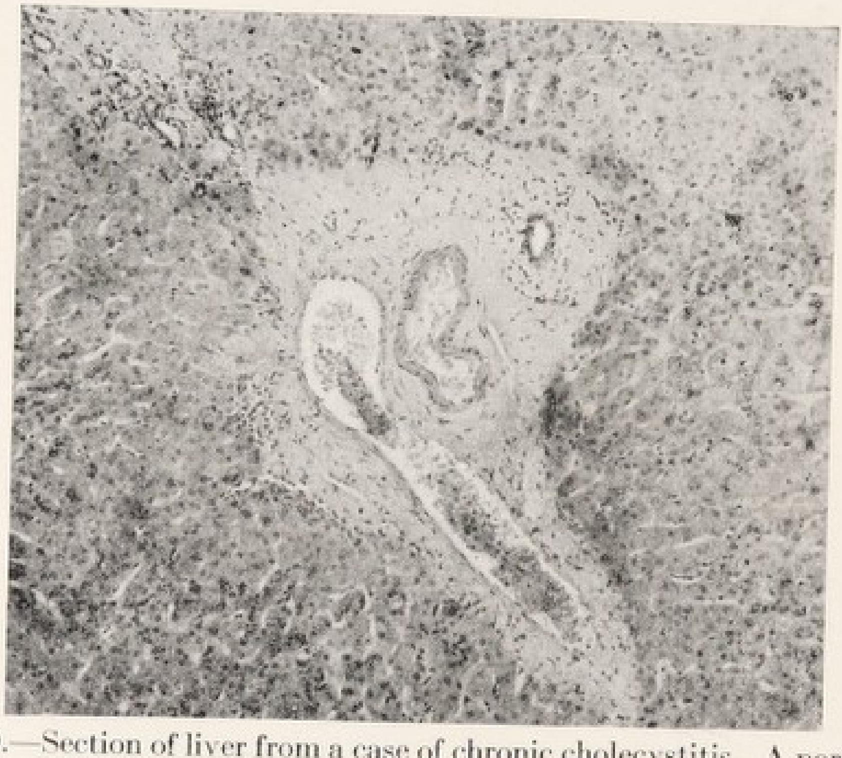

Fig. 10.—Section of liver from a case of chronic cholecystitis. A portal sheath is shown containing a vein, an arteriole, and a small bile duct. The sheath is considerably fibrosed and thickened, and contains numerous chronic inflammatory cells. These are particularly prominent surrounding the bile duct in the large tract and round the smaller ducts in the left-hand top corner of the slide.

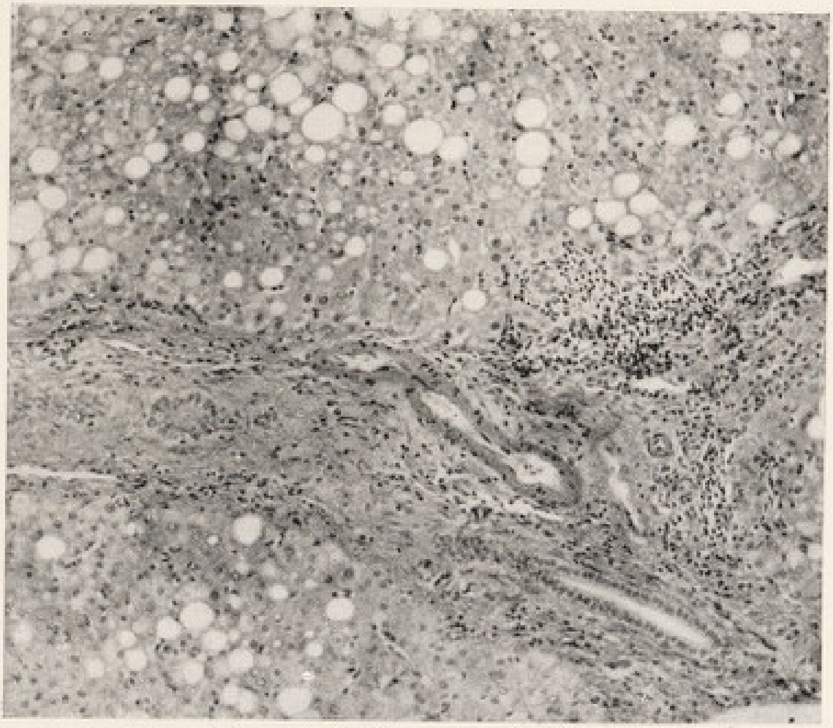

Fig. 11.—A portion of liver including a portal tract, from a case of subacute cholecystitis. There is a good deal of fatty infiltration of the liver parenchyma and a widespread inflammatory infiltration of the tract by small lymphocytes. The situation of greatest infiltration is round the small bile ducts in the bottom right-hand corner.

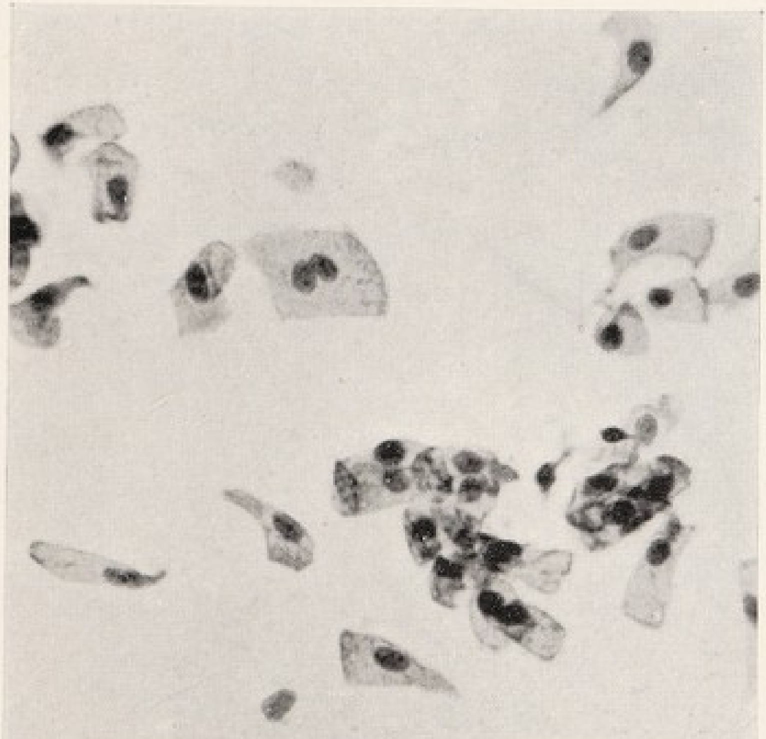

Fig. 12.—Centrifuged deposit from the bile in chronic cholecystitis. The deposit consists almost entirely of desquamated mucosal epithelium with very few inflammatory cells. None of these is seen in this slide. In cases either with or without stones the scantiness of inflammatory cells in the bile is a noteworthy feature and is some evidence against mucosal infection.

calcium is soon found upon the surface. When the gall-bladder is opened such a stone may with difficulty be wrenched from its lodgment, and may tear away a piece of the gall-bladder as it becomes free. In such conditions the mucosa is always destroyed, perhaps by pressure, and the stone is then in contact with a fibrosed muscular coat, an adventitious inflammatory coat, or the tissue of a neighbouring organ (liver, omentum, or intestine) in which it is buried. Calcium here, as elsewhere, seems to be deposited as the result of a long-continued irritation. When the cholesterin stone is becoming coated by calcium we may expect to see changes in the mucosa of the gall-bladder—inflammation, fibrosis, ulceration, and finally complete destruction. We must not, however, be betrayed into supposing that these are primary changes which, in their earlier stages, have been responsible for the origin of the stones. It seems quite clear from the examination of my cases that the changes are induced by the stones, and are therefore not primary but consequential.

There are, however, stones which are differently formed. From the first the stone is impenetrably opaque, the shadow is quite black, and it is obvious that calcium alone or in very large proportion is present. Other stones shew on *x*-ray examination a tiny speck of blackest calcium, doubtless derived from the liver, surrounded by a mass of translucent cholesterin. An examination of the interior of the gall-bladders from which stones have been removed shews that, during the months or years when cholesterol alone is found in the stones, the changes in the mucosa of the gall-bladder are slight. The membrane may be thickened, coarsened; its reticulation, at first exaggerated, may later be diminished or destroyed;

ulcers may be found here and there, and papillomata may grow from any part. But as the calcium deposit upon stones shews increase, the mucosa is found to have changed and soon to be completely destroyed, perhaps together with the submucosa, until at last nothing remains but a dense wall of fibrous tissue. No trace of elastic or muscular coat is found. This varying condition of the mucosa seems, in some measure, to correspond to the change in the blood cholesterol, which is high when the mucosa is alive and low when it is lacking or fibrosed. It is interesting to note that when foreign material formed the nucleus of stones (3 cases with copper nucleus and 1 with cotton fibre) the calcium content of the stones was higher than usual, 1 per cent. to 6.4 per cent. compared with 0.1 per cent. in the cholesterol stones (Fowweather and Collinson[28]).

The conclusion of the matter as to the pathogeny of stones in the gall-bladder appears to be this:

Infection reaches the gall-bladder, the outer coats being, as a rule, first affected. As a result the activities of this little viscus are at first enhanced, the lymphatics are engorged and the activity of the excretory or osmotic functions of the mucosa augmented. During this period the "cholesterol flood" is at its highest; increased absorption of cholesterol and its transmission to the general circulation cause hypercholesterolæmia. If the lymphatics in a further stage of inflammation become blocked and the mucosal activity continues, a deposit of lipoid or crystals of cholesterol occurs in the mucosa, œdema being prevented or reduced by means of the continued activity of the capillary circulation. The condition develops which I first described as "A disease of the gall-bladder requiring cholecystectomy."[29] To this disease MacCarty later gave the name "strawberry gall-bladder."[30] It is now generally described as "cholesterosis." This condition, it is interesting to observe, never occurs unless the cystic duct is patent and bile can freely enter the gall-bladder. The best description of it is given by Boyd[31]: the "graceful, fragile gossamer folds of mucosa are completely altered, being weighted down by dense yellow, opaque masses, much as a delicate birch tree might be weighted down by a load of snow." The yellow material is lipoid in nature and displays the properties of an ester of cholesterol. Sections of the gall-bladder often shew long-bloated villi filled with this material, and pendent only by the narrowest pedicle. If this pedicle is torn the villus will soon form the nucleus of a stone, and crystals of cholesterol will make haste to envelop it. What has happened in one villus has perhaps at the same time happened in many. And so a generation of stones is formed. Cholesterosis may, of course, be a primary condition of the gall-bladder mucosa; a too-heavy saturation of bile by cholesterin resulting in the deposit of lipoid in the villi. Such a condition exists amongst some of the 18 cases in my series in which the disease probably began in the mucosa.

When the stones begin to grow as they may so rapidly do, they begin to be themselves the cause of material changes in the gall-bladder wall, by reason of the irritation they cause, or when obstruction of the cystic duct occurs. Secondary changes in the entire thickness of the gall-bladder then result; the muscular coat and the elastic coat are fibrosed and disappear, the outer coats become increasingly thickened, a deposit of fat occurs in the walls, adhesions form, and all the changes with which we are so familiar in advanced cases make their appearance. Concomitantly, blood changes in respect of cholesterin and calcium content are observed. While the mucosa is overactive hypercholesterolæmia is, as a rule, found; when the mucosa is destroyed we may expect to find hypocholesterolæmia. Dr. A. L. Taylor and Dr. Elaine Knowles comment upon my cases, which they examined as follows: "If we select from the whole series those cases which on microscopic examination shew aggregation of lipoid cells in the mucosa, comparison with the chemical findings shew that a very definite agreement exists." The accompanying table illustrates this:

Case.	Mucosal lipoid.	Blood cholesterol.	Bile cholesterol.	Wall cholesterol.	Duration of symptoms.	Last attack.	Stones.
8	....	Slightly high.	Normal.	Slightly high.	3 years.	10 days.	Many
16	....	High.	Normal.	Low normal.	6 months.	10 days.	
24	....	High.	Low.	Slightly high.	14 days.	Days.	
30	....	High.	High.	Normal.	Many years.	7 days.	2
37	....	Normal.	High.	Normal.	8 years.	Constant.	
41	....	High.	High.	Slightly high.	Many years.	Weeks.	1
52	....	....	High.	Very high.	Years.	Recent.	2
56	....	High.	Normal.	Slightly high.	1 year.	9 days.	
61	....	High.	High.	Normal.	Many years.	Recent.	25
66	....	High.	High.	Slightly high.	Many years.	?	1
67	....	High normal.	High.	Low.	Years	?	Many.

There is, however, something to add to this. If there is increased concentration of bile, to be followed by increased absorption of cholesterol, as in hypercholesterolæmia, the supply of cholesterol may need to be maintained by a much increased output from the liver. The liver itself, that is, must be changed from the normal condition. It has already been noted that hepatitis is present in cases of cholecystitis, and I have already adduced evidence indicating that the hepatitis plays a causative rôle in its production. The possibility, also, suggests itself that a disordered function of the liver resulting from its inflamed condition is responsible for the formation of an excess of cholesterol. If this is true, then all the morbid changes met with in the gall-bladder, both anatomical and chemical, find their origin in hepatitis. This suggestion is not an extravagant one in view of the facts observed. It is not at present susceptible of proof, but is worth bearing in mind in any future research conducted on the histology of the liver and the chemical composition of the hepatic bile. The most striking piece of evidence which has been cited in view of a primary gall-bladder dysfunction is that the raised blood cholesterol returns dramatically to normal after cholecystectomy.

The whole question of the cholesterol content of the blood in infections may assume a different importance in view of these considerations. The question is at once raised as to whether in such conditions the liver cells and the gall-bladder are implicated, and if so, what significance is to be attached thereto.

The importance of all these considerations both to the physician and to the surgeon is obviously considerable. If, on the one hand, infections of the gall-bladder begin from within, then medical treatment in the early stages by the methods suggested by Lyon, and advanced by Hurst, may not only bring immediate relief, but may interrupt an impending and otherwise inevitable series of changes leading at last to irremediable conditions in which the aid of the surgeon would be necessary. It is, in my judgment, not the least of the functions of the surgeon in this present, and I hope passing, phase of his activities, to help the physician to recognise stages in disease earlier than those with which postmortem experience made us familiar, and in this way to do something to prevent disease from drifting until the surgeon alone can offer help. One business of the surgeon is to diminish surgery.

If, on the other hand, the gall-bladder infections begin from without, and are merely part of an infection which spreads widely, involving first the liver, then a far wider view is necessary, and a multitude of other most relevant questions arise. Prevention of the disease of cholelithiasis must then be sought in a study of changes earlier than any with which we are yet familiar. The relief of symptoms of the disease, however, when once established in the gall-bladder is hardly to be permanently obtained except by its removal, for if the outer coats are, as a rule, involved first, Lyon's method must, I think, in such cases lose much of its value. Our immediate enquiry must accordingly be directed not only to the clinical manifestations of early infections of the liver and gall-bladder and their antecedents, but also to a study of the early pathological changes in the liver and gall-bladder as revealed by inspection during operation. The microscopic, chemical, and bacteriological examination of any parts removed must be correlated with the knowledge so obtained.

The symptoms which my enquiries indicate as being those of cholecystitis in its earlier stages are fundamentally those which I described some years ago as the "Inaugural Symptoms of Cholelithiasis."[32] They are as follows: "Flatulence and fulness after meals, amounting sometimes to so great distress that a woman takes off her corsets or loosens them; great epigastric discomfort which may involve the right side also or pierce through to the back; early satiety during a meal, a feeling that when a small meal is taken the stomach is overfull; a sudden unaccountable sensation of intolerable nausea, described very often as 'sea-sickness'; a feeling of cold associated with slight shuddering, often coming on with great regularity; acidity and 'water-brash.'"

None of these symptoms is severe and none striking. It is in association and persistence rather than in individual character that their importance lies. The complexion of patients is often altered, although they do not realise it. After removal of the infected gall-bladder a patient will often comment upon an improvement in the complexion and remark that it is "as it used to be many years ago." Now and again in such patients a more acute disturbance of health is noticed; pain and distress in the upper part of the abdomen are associated with local tenderness, with swelling of the liver, whose edge becomes more easily palpable, and with a slight increase of tenderness. It is as though the whole liver were affected by a slight but transient inflammation. Some months, or years later an attack of hepatic colic occurs, not with the agony associated with the passage of a calculus, but with a rather more subdued but still sufficiently acute pain, which radiates to the right side and pierces through to the shoulder. In an intelligent patient these several steps may all be traced.

The criticisms which may properly be urged against this description are that it is vague, and that many of the symptoms are of great frequency, occurring even in those who consider their health quite satisfactory. I am not quite sure that vagueness, however applicable as a quality of any individual symptom, can truthfully be made to apply to their conjunction. It is the presence of all, or most of them, over periods of weeks or months, their consistency as well as their character which is significant. As to the charge concerning their frequency, I would say that infections of the gall-bladder are in truth very common. Indeed I think the statement that of all forms of dyspepsia, that dependent upon the gall-bladder is the commonest, is unassailable. We use the word "functional" in connection with dyspepsia far too easily. If we look back to the great teachers of medicine two or three generations ago, and it is well worth while to do so, we shall see that Trousseau, Thomas Watson, and others described many of the dyspepsias we now know to be dependent upon gross organic disease as "functional." The exact description of the clinical manifestations of gastric ulcer, the recognition of duodenal ulcer in its full character and frequency, the discovery of "gall-bladder dyspepsia," the demonstration of chronic appendicitis, and of visceral prolapse as causes of indigestion, have all led to a diminution in the number of "functional affections of the stomach." A still further contraction, perhaps the greatest of all, will occur when we are able fully and clearly to recognise the effect upon the health for which infections of the gall-bladder, its antecedents and its consequences, are solely responsible. The uncertainty which may attach to the clinical history is relieved or removed by the Graham-Cole method of cholecystography. The value of this method does not attach itself so much to the diagnosis of cholelithiasis, in which the proportion of errors is always small, but to the study of normal physiology and of pathological changes in the gall-bladder. Dr. Rowden pointed out to me almost at the beginning of our investigation of cases by this method, how likely it seemed that the negative evidence would prove to be most valuable in those early cases of gall-bladder disease in which our interest was then chiefly engaged. In a few cases diagnosed as early cholecystitis, either no shadow of the gall-bladder was seen or perhaps only a faint shadow after a long interval. When an operation was performed, we sometimes hesitated to remove a gall-bladder which shewed only a slight degree of structural change. But its subsequent examination, and especially the after-history of the patient, shewed that cholecystectomy had indeed been necessary. It soon became evident that one of the main functions of the gall-bladder, the concentration of bile, was checked at a time when the external appearances of the viscus were only slightly altered, and further that in this precocious stage the "inaugural symptoms" were clearly elicited. Absence of a shadow or reduction in its density, after the intravenous injection of the dye, may be due to:

1. Hepatic insufficiency.
2. Blockage of the cystic duct.
3. Deficient power of concentration in the gall-bladder.
4. Destruction of the mucosa of the gall-bladder associated with ancient calculi.
5. The presence of so many stones that the gall-bladder is "choke-full."

In our search for the earliest pathological changes and for knowledge of the symptoms they cause, it is obviously the deficient power of concentration that will be of chief interest. I have come to the clear conclusion that the first of the changes to be demonstrable by any of the means we now possess is this loss of function by the mucosa. And it is possible, having regard to our observations upon the earlier infection of the outer coats, that diminished power of absorption is due to the implication of the lymphatic vessels. The mucosa does not concentrate the bile, because the lymphatic vessels or cicatrized capillaries are unable to carry away the fluids which normally excreted. If, therefore, "inaugural symptoms" are present, and if a cholecystographic shadow is absent, diminished in opacity, or delayed in appearance, the integrity of the gall-bladder may safely be impugned and operation for its removal performed.

The appearances presented by the early pathological gall-bladder vary. There is often a lack of the usual lustre, the walls normally deep-blue in colour are a little paler and, perhaps, a little thinner, there is apt to be a deposit of fat, especially toward the pelvis or along vessels. Adhesions are present, and the cystic gland is enlarged, while in later stages the wall becomes thickened and fibrous in texture. The changed appearance is often so slight that reluctance to remove the gall-bladder may naturally be felt. But the subsequent examination of the wall will convince both pathologist and surgeon that the extent of the involvement justifies ablation. In such examinations attention has hitherto been chiefly centered on the mucosa; it is, however, the outer coats which call for the most careful scrutiny.

I have no doubt that until we are able clearly to understand and to control the earlier symptoms of cholecystitis, and its foregoing conditions, removal of the gall-bladder should be performed more frequently than is now the custom. In cases of inveterate mild dyspepsia I have many times hesitated whether to extirpate the gall-bladder which did not seem much changed. Yet when I have not removed it I have found symptoms unrelieved, and have been compelled to operate again, with great satisfaction to my patient. I am happy to find this experience corroborated by one of the shrewdest and sanest of my surgical friends, Starr Judd of Rochester.

Advance in this direction must be slow and wary, and any case dealt with should receive the most exhaustive enquiry beforehand, and the parts removed, the gall-bladder, and perhaps a tiny fragment of the liver, should be examined with care and completeness; examinations of the blood and bile, in respect at least of their cholesterol content, may be made concurrently. I know no department of medicine which so much requires that the physician and the surgeon and all laboratory workers should be in league together.

FOOTNOTE.—This address is based upon an experience of many hundreds of cases of cholecystitis operated upon in recent years, but more particularly upon a series of 81 cases, in which the following examinations were made. Before operation the cholesterol and calcium contents of the blood were estimated, in many cases a Rehfuss test-meal was given, and in a few a duodenal intubation was made. The gall-bladders removed were first examined by Dr. L. A. Rowden and were then opened; cultures of the bile, of the gall-bladder wall were made; the calcium and cholesterol content of the bile estimated, and sections made of the gall-bladder wall. In some cases the blood was examined for cholesterol at varying periods after the operation.

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