British Medical Association.

NINETY-SEVENTH ANNUAL MEETING, MANCHESTER, 1929.

President's Address

ON

THE DEBT OF MODERN SURGERY TO THE ANCILLARY SCIENCES.

BY

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[BEFORE commencing his address the President welcomed the British Medical Association to Manchester and Salford, and expressed his thanks for the great honour of his election to its presidential chair and for the invaluable assistance of medical and lay friends in the preparations for the meeting; he referred to the changes in the personnel of the local profession and of the cities' hospital arrangements since the Association's fourth visit to Manchester in 1902, and mentioned the work during the great war of Manchester's Territorial Hospital—the 2nd Western General.]

In no sphere of the world's activities has a single discovery constituted a sharper dividing line between two stages of its history than in the division of surgery into two periods—pre- and post-Listerian—by Lister's epoch-making discovery of the antiseptic treatment of wounds. Prior to 1865, the year of its first application, the surgical wards of our hospitals, infested as they were by erysipelas, pyaemia, and hospital gangrene, had come to be looked upon as veritable death traps, and a greater measure of success often attended a surgical operation performed in the simple environment of the poorest home than a similar one under the best conditions afforded by the hospitals of that date. The introduction of anaesthesia—surely one of the most merciful events in the history of mankind—had, nevertheless, unwittingly served but to augment the death rate of operative surgery. By abolishing the element of pain therewith associated it had increased the frequency with which surgical operations were performed in theatres and wards where septic infection was the rule, almost without exception, and where suppuration was still regarded as the normal process of wound healing.

Lister has changed all this, but the full extent of that change is very difficult to realize by those of us who, practising surgery sixty years later, and having, therefore, of necessity, had no personal experience of the conditions under which surgeons of the fifties and sixties of the last century had to work, accept the priceless benefits of this radical change almost as a matter of course, and often with very imperfect appreciation of the evolutionary developments that have rendered possible the brilliant surgical work that is being carried on all over the civilized world to-day. As skilled surgical craftsmen, and in their knowledge of anatomy and of the gross manifestations of disease, the older surgeons were in no sense inferior, and yet the ever-present spectre of septic infection rendered each surgical effort a truly perilous adventure, keeping the surgeon in a state of constant anxiety until the wound was safely healed—an anxiety no less disturbing in that, the cause of the infection being unknown, no care or foresight could avail to prevent it.

Commonplace, though none the less true, has now become the statement that Lister's work has revolutionized surgical practice: it has for all time freed surgical operations from the dreaded risks of their most dangerous complication—septic infection—thereby not only vastly increasing their safety, but enormously diminishing the extent of pain and suffering formerly connected therewith. When we consider

the incalculable number of lives already saved, the immeasurable amount of suffering already prevented, and the continuation of these benefits throughout the ages yet to come in which surgery will continue to be practised, we must admit that the description given of Lister as the greatest human benefactor the world has yet known is in no sense an exaggeration.

In the numerous Listerian centenary celebrations held two years ago throughout the civilized world the tale of his great discovery has been repeatedly unfolded—how that, like most epoch-making discoveries, it was at first received with incredulity and opposition, against which advancement was slow and laborious. To Edward Lund belongs the credit of introducing Lister's work to Manchester and of establishing antiseptic treatment at the Royal Infirmary. Refused at first by the Infirmary authorities of that day the provision of the requisite antiseptic dressings, Lund for a long while supplied these for his Infirmary patients at his own expense, and mostly prepared them with his own hands. His enthusiasm for Listerian principles and his success in their application steadily wore down all opposition, and antiseptic measures became gradually adopted by his surgical colleagues.

My personal acquaintance with surgery at the Manchester Royal Infirmary dates from 1893, when the transition from antiseptic to so-called "aseptic" methods was just commencing. The carbolic spray had then been given up, yet all operation wounds were still flushed with a strong solution of either carbolic acid or mercury perchloride and thoroughly dusted over with iodoform before being sutured, drainage being almost invariably employed. I well recall an occasion, some two years later, when Walter Whitehead, who was certainly one of the most go-ahead surgeons of his day, announced that he would perform an operation for the removal of a cancerous breast without applying any antiseptic to the wound. Nothing was used save boiled water, nor was the wound drained. This, at that date, very unorthodox procedure excited keen interest among the house-surgeons and dressers, and considerable misgivings were freely expressed as to the result. The wound, however, healed with perfect primary union, and with this encouraging experience antiseptics came to be applied less freely to operation wounds—aseptic gradually replaced antiseptic surgery. The basic principle of aseptic surgery is that everything which comes in contact with the wound during the course of an operation must be sterile, so that, no germs having been introduced, the application of antiseptics is not only unnecessary, but is actually harmful to a degree dependent upon the amount of tissue damage they inflict. In some quarters "aseptic" is spoken of as if it were a rival method to "antiseptic" surgery, and as if it represented a great advance upon anything that Lister had taught. Far from any such antagonism, however, aseptic surgery is but the natural complement and logical outcome of Listerian principles, and although everything else used in a modern aseptic operation may be sterilized by heat, yet the surgeon, worship he never so devoutly at the shrine of asepsis, must use antiseptics for the preparation of the skin of his patient and of his own hands.

As a sequel to the increased safety engendered by the practice of Listerism there naturally followed the extension of surgery into anatomical fields hitherto approached only when urgent necessity demanded the repair of grave injury. Concerned at first mainly with the limbs and the more readily accessible parts of the trunk, attacks were soon made upon the great cavities of the body—the cranial and spinal cavities, the abdomen, and the chest. Thus the operative field has been gradually extended until now every part of the body has been brought within the sphere of surgical activity. Even the heart—always prominent in popular imagination—is no exception; its stab wounds have been many times successfully sutured, bullets have been extracted from its walls and even from its cavities, and plastic operations have been performed actually upon its valves, while injection of drugs directly into the heart muscle, and massage of the heart through either an abdominal or a thoracic incision have become part of the routine treatment of cardiac failure during anaesthesia. At the present time prominent surgical attention is being paid to the last remaining surgically unfamiliar system—the sympathetic nervous system—and to the last remaining organ—the suprarenal body.*

Of the advances that have occurred in almost every branch of surgical work during the present century (a period almost coincident with that since the last visit of the British Medical Association to this city) I think it will be generally admitted that the most outstanding is that in the department of abdominal, and especially of acute abdominal, surgery. This is locally illustrated by a comparison of the abdominal surgery of the Manchester Royal Infirmary at the beginning with that at the end of the first quarter of the present century. During this period, of the general surgical operations the proportion of those on the abdomen has risen from 10.97 per cent. to 56.99 per cent., the annual number of operations for acute abdominal conditions from 82 to 1,241, while their total mortality has diminished from 36.5 to 8.1 per cent. A closer analysis shows that the percentage mortality of operations for strangulated hernia—the only frequently performed urgent abdominal operation in 1900—has fallen from 22 to 9.4, for acute intestinal obstruction from 44.4 to 20.8, for perforated gastric or duodenal ulcer from 80 to 11.1, and for acute appendicitis from 64.2 to 5.1. The enormous increase in the number of operations for acute appendicitis constitutes the most prominent feature of this period. Thus in 1900 only 14 operations were performed in the Manchester Royal Infirmary for this condition—all for either appendicular abscess or peritonitis, there being no recorded instance of removal of an acutely inflamed appendix prior to the onset of one of these complications; in 1924 there were 798 operations for acute appendicitis, of which 337 were performed sufficiently early to permit of removal of the appendix without drainage.

Similar progress, though perhaps less dramatic, has been maintained in the surgery of non-urgent abdominal conditions, the annual number of operations for which at the Royal Infirmary has increased from 184 in 1900 to 1,810 in 1924. The increases shown by the four most frequently performed of these operations are—those for quiescent appendicitis from 24 to 407, for radical cure of hernia from 108 to 333, for gastric and duodenal ulcer from 1 to 250, and for gall-stones from 3 to 176.

Time does not permit me to make more than a passing reference to the present-century advances in other departments of surgical work, though specific mention must be made of the wonderful progress in orthopaedic surgery under the stimulating influence of Sir Robert Jones, of the extraordinary achievements during and since the war in plastic and reconstructive surgery, more especially of the face and jaws, prominently associated in this country with the name of Major Gillies, and of the great increase in our knowledge of the surgical treatment of tuberculosis of the lungs and of other intrathoracic diseases.

This progress in surgery—which, I feel strongly, will compare favourably with that attained in any other branch

of the arts and sciences—has not, nor could it have been, achieved without the material assistance of the contemporary advances in the allied sciences; it is, indeed, this which constitutes my main thesis to-night. Modern victories are rarely won single-handed, and the greater the number, the more effective the strength and the more vigorous the activities of the allied forces whence assistance is forthcoming, the more confidently may we look forward to a victorious issue. Prior to the time of John Hunter surgery was almost entirely an art—a glorified handicraft, taught and practised quite independently of all other arts and sciences, devoid of any physiological basis for its methods, and essentially empirical in its attempts at progress. Hunter, deeply imbued with the scientific spirit, introduced into surgery the method of careful observation, collection, and collation of facts, and their thorough testing by direct experimental investigation, rather than that of trusting to theories founded on insufficient and unproved evidence. "Don't think—try" was his favourite exhortation. He it was who first gave allies to surgery, urging that surgery should be regarded as a branch of natural science, to be studied in its appropriate relationship to all the other branches, thus bringing it into close association with chemistry, physics, biology, comparative anatomy, physiology, and pathology. Had the microscope been available in Hunter's day he would doubtless have added to these bacteriology.

Every important discovery in the natural sciences since Hunter's time has exerted its influence upon contemporary surgical thought and practice, and overwhelming indeed would be surgery's debt to its allies were it not offset by a corresponding counter-debt for the help rendered to them in return by the great advances that have been made in surgical knowledge.

Though the choice for consideration to-night of a few only of the numerous component factors of this debt of modern surgery to the ancillary sciences must necessarily prove an arbitrary and rather an invidious task, yet I feel that the consensus of surgical opinion will endorse my selection of physics and of physiology as the two sciences to which, in recent times, surgery is most indebted; and further, that of the many useful applications in surgery of the results of researches in physics three have established a special claim upon our attention—x rays, radium, and light therapy.

RADIOLOGY.

The x rays, discovered by Wilhelm von Röntgen of Würzburg in 1895, were early applied to the diagnosis of pathological states in the human being, and thus was founded the science of radiology, whose subsequent brilliant achievements not only constitute one of the most important chapters of progress in medical affairs during the present century, but also open up vistas of still greater possibilities for the future.

The organs and tissues of the body vary in the degree of resistance they offer to the passage of the x rays, and it is upon the relative opacity of an organ to that of the tissues in its immediate vicinity that the possibility of demonstrating its shadow upon the radiographic plate or screen depends. The bones and teeth are very much more opaque than the soft structures, and cast the deepest shadows; the lungs are the most translucent, so that the heart placed between them is relatively opaque, and casts a very definite pulsating shadow. The kidneys are seen only to a very limited degree, since they are surrounded by tissues of approximately the same density as themselves; were they situated in the thorax their visibility would equal that of the heart.

Foreign bodies are displayable in proportion to their density, those of a metallic nature taking the first place. Had we not had available during the great war the assistance of the x rays in the detection and accurate localization of the bullets, shell fragments, and other metallic particles lodged in the tissues of so many of our wounded, war surgery would have had a very much less successful tale to unfold. Calculi are opaque to the x rays proportionately to the amount of lime salts they contain, those of the urinary tract being nowadays displayed with

* Oppel of Leningrad, in *Annals of Surgery*, June, 1928, reports 130 adrenalectomies for Raynaud's disease, and other forms of "hyperadrenalinaemia."

such reliability that operations for the removal of renal and ureteric stones are practically never undertaken unless the presence of the calculus has been previously radiographically demonstrated. In the bladder, it is true, stones are occasionally met with composed of uric acid only and quite translucent ("radiolucent") to the x rays; such may easily be overlooked even if of large size, but fortunately we have, in the cystoscope, a certain means of their recognition. Calculi in the salivary and other glands are readily displayed, while, with improving technique, gall-stones are being shown in a steadily increasing proportion of cases.

The assistance of the x rays in the diagnosis and treatment of fractures and dislocations has proved invaluable, and the advice given recently by the council of the Medical Defence Union in a circular letter to its members, to insist upon radiography in every case of suspected fracture, would appear to be extremely sound from several points of view other than the intended one of defence against a possible legal action for malpraxis. Radiography soon taught us that in a large proportion of what were formerly considered to be merely "sprains" of joints some definite bony injury was present, the overlooking of and consequent failure to apply appropriate treatment to which explains the popular idea that "a sprain is worse than a break." Many incomplete and impacted fractures, and some of those without displacement, cannot be detected by any other means than radiography, and of this the general public is becoming aware. The public is, however, much too prone to estimate the success or failure of treatment of a fractured bone by the extent of the anatomical deformity displayed in the radiogram, rather than by the functional result; to the popular mind the "setting" of a fractured bone seems to imply that the radiographic picture should show the perfect apposition of the broken surface—an ideal which, though frequently most eloquently stressed by counsel for the plaintiff in an action for malpraxis, is, as the medical profession knows only too well, rarely attainable apart from open surgical operation.

X-ray apparatus is now so efficient that the finest details of structure of the bones are easily shown, and the slightest changes therein induced by early disease can be readily detected. Thus the earliest manifestations of tubercle, of rickets, of syphilis, and of new growths as they affect bone are readily recognizable, and such knowledge conduces to earlier and more effective treatment. One of the commonest applications of radiography of the present day is that to the sockets of the teeth, and many a local source of origin of "focal sepsis," otherwise inexplicable, has been thereby disclosed.

At an early stage of radiography its utility was vastly extended by the introduction of substances opaque to the x rays into parts of the body otherwise radiolucent, thus rendering them visible. The ramifications of sinuses in the soft parts were demonstrated radiographically by previously injecting them with bismuth paste. The introduction of the bismuth and, later, of the barium meal has been the outstanding advance in radiology, and has completely changed many of our former ideas regarding the anatomical position, the form, and the physiological movements of the different parts of the alimentary tract, while it has added in a truly marvellous degree to our knowledge of their pathology. Radiology, to the infinitely greater safety of the patient, has entirely displaced the bougie in the diagnosis of oesophageal obstruction, and yields an accuracy of information as to the exact situation, extent, and nature of the cause of the obstruction previously quite unattainable. It thus differentiates readily between simple cicatricial stricture, malignant stricture, compression of the oesophagus by tumours from without, and the very imperfectly understood muscular obstruction at its lower end, to which the term "cardiospasm" is applied. The presence, situation, size, and shape of pharyngeal and oesophageal diverticula are demonstrated with certainty by means of the opaque meal, which has also taught us that diverticula of the alimentary canal, though most frequently met with in the pelvic colon, may occur also in the rest of the large intestine, in the appendix, the small intestine, the duodenum, and even in the stomach. The recognition of gastric and duodenal ulcers, of their complications, such

as hour-glass contraction and pyloric stenosis; of gastric cancer, more particularly in its earlier stages; of obstructions of the intestines, especially that of carcinoma of the colon, by means of the opaque enema, either alone or in combination with the opaque meal; of displacements of the viscera such as are observed in diaphragmatic hernia or in visceroptosis, and the demonstration by Graham's method of the outline of the gall-bladder some ten to twelve hours after the administration of tetraiodo-phenolphthalein, owing to the power of this viscus to concentrate the bile, in which the drug is excreted, to such a degree as to prove opaque to the x rays—all these constitute veritable triumphs of radiology, and have enormously facilitated the diagnosis of abdominal conditions.

Much the same may be said of the application of the opaque ureteral bougie and of the introduction of opaque media into some part of the genito-urinary tract during radiography—pyelography, ureterography, cystography, or urethrography, according to the portion of the tract concerned. Of these, pyelography has been most employed, and has disclosed alterations in the size, shape, and position of the renal pelvis, calyces, and ureters which have proved of the highest possible value in the diagnosis of renal pathological states.

The introduction into the trachea of the opaque medium lipiodol—a combination of 40 per cent. iodine with oil of poppy seeds—renders the bronchi and their ramifications visible upon a radiogram taken very shortly afterwards, and has been found useful in determining the relation of a foreign body in the lung to the nearest accessible bronchus, in demonstrating the outlines of lung abscesses, the presence and extent of bronchiectasis, the existence of a broncho-pleural fistula, and the extent of malignant growths involving the bronchi. Lipiodol was originally recommended by Sicard of Paris in 1921 for the localization of the site of blockage of the subarachnoid space by spinal cord tumours. Introduced into the upper part of this space, as by injection into the cisterna magna, the medium falls by gravity to the level of the upper limit of the obstruction, and can there be radiographically shown. By injecting into the lumbar sac an "ascending" mixture of lipiodol and olive oil, of lighter specific gravity than the cerebro-spinal fluid, the lower extent of the subarachnoid block can be defined. The method is not altogether devoid of danger, and lipiodol, once introduced, appears to remain unabsorbed for a long period, even for years. The injection of lipiodol into the uterine cavity has been used to indicate its size and shape, and any encroachment upon it, as by a growth, while the failure of the medium to pass along one or both Fallopian tubes has been utilized in the diagnosis of their obstruction in cases of sterility.

Another method of altering the relative densities to x rays of adjacent soft structures, and thus rendering their outlines visible, is the introduction of a gaseous medium—air, oxygen, or carbon dioxide—as into the perirenal tissues, thereby allowing the outline of the renal shadow to be readily discerned; or into the peritoneal cavity, when the liver, spleen, and kidneys are rendered visible. The withdrawal by puncture through a drill hole in the skull of a small amount of fluid from one of the lateral ventricles of the brain and its replacement by air or oxygen has allowed the outlines of the ventricles to be rendered visible upon the radiographic plate; their increased size in internal hydrocephalus can thus be readily demonstrated, whilst the position relative to the ventricle of an otherwise obscure cerebral tumour can often be accurately ascertained.

The growing importance of radiology is evidenced by the steadily increasing proportion of patients who pass through the x-ray department of our hospitals either for diagnosis or treatment. At the Manchester Royal Infirmary this proportion has gradually risen from 1 in 100 in 1908 to 1 in 24 in 1912, 1 in 11 in 1917, and 1 in 5 in 1928.

RADIUM.

Radium was discovered in 1898 by Professor and Madame Curie in a deposit of pitchblende from Joachimstal in Bohemia, and was at first a monopoly of the Austrian Government. This monopoly was transferred to the American Government in 1913 owing to the discovery in Colorado and Utah of carnotite—a mineral which, although

the proportion of radium it contained was as small as one gram in 400 tons, nevertheless proved profitable to work owing to the ease with which the radium could be extracted. The finding of some very rich lodes of pitchblende in the Belgian Congo in 1921 has now placed the monopoly in the hands of a Belgian syndicate, who, in their factory at Oolen, at present supply most of the world's demand. It requires from thirty to forty tons of ore to yield one gram of radium, and its extraction necessitates spacious premises, much labour, and many highly skilled operatives, all these factors being reflected in the present market price of about £12,000 per gram. This monopoly seems likely to persist for some time, and only the discovery of a new source of really rich deposit can ameliorate the present situation.

Radium emits rays of three varieties—alpha, beta, and gamma—the last, similar to the Roentgen rays, and of high penetrative power, being those mainly used in deep treatment. Upon both animal and vegetable life radium has a decidedly detrimental effect, which is not, however, exercised equally upon all tissue cells, and even upon normal tissues radium has a decidedly selective action. Thus the cells of glandular structures, especially those of the ovary and testis, are much more susceptible than those of fibrous tissue, while muscle, cartilage, and nerve cells are the least sensitive. Actively dividing cells are the most vulnerable, and the cells of malignant growths, in which activity of cell division is a prominent feature, are more readily affected by radium than the other cells of the body. Upon this selective action the therapeutic value of radium in cancer depends, and our problem is to determine the exact dose that will exert the maximal destructive effect upon the cells of the malignant growth with the minimal upon those of the other tissues. There is a minimal dose below which no destructive action occurs, and many believe that these weak irradiations can stimulate the growth of tumour cells, and even stir into activity cells actually quiescent. The total dosage of radium, calculated in milligram-hours, can be applied either as a large amount of radium acting for a short time, or a small amount acting for a long time, and opinion is not yet decided upon the optimal dosage for each type of growth. On the one hand, by prolonging the duration of exposure, a greater number of cells will be adversely influenced during the vulnerable stage of active cell division; on the other hand, it has been shown experimentally that repeated sublethal doses may actually increase the resistance of the tumour cell to radium, and radiation treatment should, therefore, be concluded within a reasonably short time, and not indefinitely repeated.

As a therapeutic agent radium has been found of considerable value in non-malignant conditions—such as naevus, keloid, lupus and other skin diseases, exophthalmic goitre, and benign tumours—but it is in the treatment of malignant disease (including rodent ulcer) that its chief interest to us lies. Restricted at first entirely to cases too advanced for radical operative treatment, its scope has within the last few years been extended, either alone or in combination with surgery, to the treatment of operable cases. There has arisen a special branch of surgical technique—"the surgery of access"—concerned with the planning of operative procedures for the appropriate exposure of deeply seated malignant growths in order that radium tubes may be placed in correct relation thereto—as when a rectal carcinoma is exposed by removal of the coccyx and lower portion of the sacrum, an oesophageal carcinoma through the posterior mediastinum after rib resection or across the pleural cavity by lateral thoracotomy, or an intralaryngeal growth through a "window" cut in the thyroid cartilage. Modern methods of radium application have met with such considerable success in cancers of the skin, of the cervix uteri, of the mouth and tongue, and of the larynx, that there is an increasing tendency in these cases to prefer radium to operative treatment, at any rate so far as the primary growth is concerned. The comparatively slight disturbance of radium tube insertion, or of radium bomb treatment, their lesser risks, and the absence of that mutilation necessarily associated with a radical surgical operation, and which, as in the case of the tongue, may prove a considerable and permanent disadvantage, are

factors favourable to radium, and should tend to overcome the natural reluctance of the average patient to submit to early treatment. It is, however, upon the end-results that the question must be ultimately decided, and these are not yet sufficiently known in the case of radium for a conclusive judgement, although some promising series of five-year statistics have been reported. In many cases the best results are obtained by a combination of radium treatment with surgery, as when the radical operation for cancer of the breast is associated with the implantation of radium tubes or needles into the supraclavicular and anterior mediastinal regions. At the present moment expert opinion seems to favour reversion to the external application of radium, either alone or in combination with radium tube insertion and very short wave-length x-ray irradiation. There are, however, two most important changes from the surface applications as originally practised: (1) the much larger quantities of radium used—up to 4 grams—and (2) the much greater distance from the skin—as much as 16 cm.—at which it is applied, thereby ensuring a more uniform dosage to all parts of the area irradiated, with lessened risk of cutaneous damage. This "bomb" or "cannon" treatment—as at present carried out in Paris, Brussels, Stockholm, and on a smaller scale at the Westminster Hospital, London—is considered by many likely to prove the method of choice in radium therapy, and it certainly deserves to be tested very thoroughly, should a sufficiency of radium be forthcoming. The still very high cost of radium in spite of the removal of the one-third *ad valorem* Government duty, and its restricted supply, are matters requiring urgent attention, and every means must be taken not only to increase its production, but also to ensure that the most efficient and most economical use is made of such supply as is already available, having regard to the absolute necessity, in this connexion, of maintaining an intimate association between treatment and research. The technique of radium therapy is highly specialized, and such work should be centralized, and restricted to the expert staffs of special institutions established in a few of the largest cities of a country. Until the supply of radium becomes less inadequate to cope with the increasing demand it may be advisable to arrange for a "night" as well as a "day" staff of workers at these institutions in order to minimize the number of hours ("radium-hours") during which any of the radium is unemployed in treatment.

ACTINOTHERAPY.

Heliotherapy—treatment by sunlight—is probably as old as human history. Hippocrates (460 to 370 B.C.) refers to the effect of sunlight in promoting health, and recommends sufferers from various ailments to walk about naked in the sun as much as possible—a simple remedy, which seems, however, to have been overlooked for many subsequent centuries.

At the end of the last century a considerable proportion of the beds in the hospital wards of our large cities was occupied with cases of tuberculous disease of the bones, joints, and spine, and other forms of "surgical" tuberculosis, for which operations, often of a very extensive and mutilating nature, and frequently requiring repetition, were considered the only chance of a cure. How frequently they failed, and, even when successful in saving life, the unsightly deformities and fearful defects of function that resulted, are some of the unpleasant memories of those of us who practised at that time. No more beneficent change has occurred in any department of treatment than in that of surgical tuberculosis during the past quarter of a century.

Thanks to the pioneer work of Bernhard and Rollier in Switzerland, and of Sir Henry Gauvain and Sir Robert Jones in this country, these mutilating surgical operations are things of the past. Surgical tuberculosis is nowadays treated by a general exposure of the body to sunlight in the open air in summer, and to artificial sunlight in the winter or whenever natural sunlight is not available. This should be combined with local treatment so designed as to ensure complete immobilization of any active focus, the removal of any pressure or weight-bearing, the correction, so far as is possible, of any existing deformity, and the antiseptic care of any discharging sinuses. Active surgery is limited almost

entirely to the evacuation of any cold abscesses that may develop, although in tuberculous spinal disease operations (Albee's, Hibb's) are occasionally performed, not as a direct attack upon the affected tissues, but to ensure better immobilization of the morbid focus in the vertebral bodies by producing ankylosis of the spinous processes of the diseased vertebrae and of those immediately above and below. Under this modern plan of campaign not only is victory assured in a much greater proportion of cases, but the bronzed and robust-looking bodies of the patients under sunlight treatment contrast pleasantly with the waxen faces and wasted limbs of the old days, while the local focus of disease heals with the minimum of deformity and the maximum preservation of function.

Treatment by ultra-violet radiation (actinotherapy) is now being extended to rickets and other general diseases, to most forms of skin disease, and to many disorders of the circulatory, respiratory, alimentary, nervous, and genito-urinary systems, as well as to those of the special senses. It has, in fact, assumed the dimensions of a "boom" treatment, and "sunray" centres are being established all over the country, not only as private ventures, often controlled by laymen only, but also at the municipal bathing establishments of many of our cities and towns, while there are sunbaths in many factories and at "pitheads" in several of our coal-mining districts.

The ultra-violet rays are, however, far from being innocuous, and their correct dosage is a matter of great importance and of careful individualization, since what is a safe dose for one may be dangerous to another. Over-exposure to their influence produces sleeplessness, restlessness, loss of weight, lassitude, and even sickness, while severe burns and serious forms of dermatitis may result in sensitive persons. Moreover, some ailments are adversely influenced by ultra-violet ray treatment—notably chronic nephritis, arterio-sclerosis, and quiescent tuberculosis, the last of which may easily be stirred into renewed activity. It is therefore in the public interest that the prescription of ultra-violet rays be restricted to the medical profession, and that their application be undertaken only by those who have received a proper course of training for this special work.

In view of the risks to the public involved in the use of electricity and radiation as methods of treatment by untrained and unqualified persons, the Representative Body of the British Medical Association, at the last Annual Meeting (July, 1928), expressed the opinion that suitable courses of training should be organized under medical direction for persons wishing to administer this form of treatment; that persons who have satisfactorily followed such a course should be entitled to have their names entered on an approved roll; that they should undertake to treat only patients sent to them by medical men, and that medical men should refer their patients only to those persons whose names are on the approved roll. Along these lines the Society of Apothecaries of London, acting in concert with the British Medical Association, has recently agreed to set up a standard to which persons practising physio-therapeutic treatment should attain, to institute a diploma, and to establish a register of those found qualified to serve as "biophysical assistants," such registration to entitle the appendage of the letters "B.P.A." to their names. The unqualified, unregistered chemist, dentist, and midwife are forbidden by law, and it seems only logical that the unqualified electrotherapist, who handles therapeutic measures equally potential of danger, should be placed under similar legal control.

PHYSIOLOGY.

Physiology has often been referred to in the past as the handmaiden of medicine, but such a description very inadequately represents its present status as a proud and independent branch of true science—the science of life itself. Rather must it be described as the essential foundation of modern medicine and surgery, as the means by which many of our former purely empirical methods of treatment have been placed upon a rational basis, and as the main factor by which the practice of medicine and surgery is daily becoming proportionately more of a science and less of an art. That the element of art must continue

permanently to play a considerable part in surgery is self-evident when we remember how largely handicraft enters into its daily routine, but the merely artistic aspect of surgery has now, we may fairly claim, been brought to so high a degree of perfection that it is not so much upon outstanding advancements in surgical artistry that we must rely for future progress as upon a more thorough understanding of the physiological principles involved in our work, and their application to what is, after all, the great aim of surgery—the restoration of deranged function to the normal. The greater comprehension the surgeon obtains of what constitutes normal function the better equipped is he to achieve this aim, and to improve his methods by means which were not possible in the days when physiology was less advanced. The surgeon and the physiologist must tread the path of progress hand-in-hand, to the great advantage of each, since the debt between them is essentially a mutual one. For the success of his experiments upon animals the physiologist has to depend largely upon the methods of modern aseptic surgery, and has, therefore, a very vital interest in any improvements in surgical technique that may from time to time accrue. Moreover, though it is true that many discoveries made by physiologists which have found valuable practical application in medicine and surgery have originated purely in the search after truth and without any thought of their possible clinical utility, yet, on the other hand, there are many instances where clinical observation has been the starting-point of physiological researches which have ultimately proved of the greatest benefit in the treatment of human disease. One of the most impressive illustrations of this is yielded by the development of our knowledge of the localization of function in the cortex of the brain.

Prior to 1861 physiologists taught us that the brain acted as a whole, without any allotment of specific function to localized areas within it, but with all its parts working equally together. In that year Broca demonstrated to the Anthropological Society of Paris the brain of a man who had lost the power of speech for forty-one years, and showed that the only pathological change was softening of the third left frontal convolution. From this and other observations Broca deduced that this area was the seat of the faculty of articulate speech, and he further made the revolutionary suggestion that other areas of the brain might similarly be associated with special localization of function. In 1869 that great clinical observer Hughlings Jackson, from a study of cases of fits, and of hemiplegia, in which he carefully correlated the clinical manifestations with the necropsy findings, advanced the opinion that the cerebral cortex could be divided up into separate areas with distinctive function in regard to voluntary movement. In 1870 Fritsch and Hitzig applied the methods of experimental physiology, and by means of a galvanic current electrically stimulated the exposed cerebral cortex in dogs; they found that co-ordinated movements of certain muscles on the opposite side of the body invariably followed upon stimulation of certain definite areas of the cortex. In 1873 David Ferrier repeated and extended these experiments to the monkey, and utilized the faradic in preference to the galvanic current. He proved conclusively that certain portions of the cortex are definitely associated with specific motor and sensory functions, and his results were subsequently confirmed and extended by Horsley, Schafer, Beevor, Sherrington, and others who made similar experiments in the higher apes and in man. The way was thus paved for the application of these experimentally obtained results to man, and in 1876 Macewen (the late Sir William Macewen) of Glasgow correctly diagnosed an abscess in the immediate vicinity of Broca's lobe, the result of an injury to the skull. Unfortunately consent to operation could not be obtained, but after death the friends allowed the operation to be performed just as had been intended during life, when the finding of an abscess the size of a pigeon's egg in the white matter of the bases of the second and third frontal convolutions showed how accurate had been the diagnosis. In 1879 Macewen successfully operated upon two cases—one of abscess and one of tumour; in 1884 Godlee reported an operation for cerebral tumour; in 1886 Horsley recorded three cases of cerebral surgery; and in 1888 Macewen, in his address to the British Medical Association in Glasgow, recorded 21 cerebral operations with 18 recoveries, the three fatal cases all being *in extremis* when operated upon.

Since that time the continued experimental investigations by physiologists, the carefully recorded clinical observations of physicians, and their correlation with the results either of necropsy findings or of the operative disclosures of their surgical colleagues, have each played their part in the acquisition of the infinitely fuller, though even yet far from complete, knowledge of the localization of cerebral function of the present day—a knowledge which constitutes the essential basis of the great advances that have occurred during the present generation in the realm of cerebral and intracranial surgery.

Again, our knowledge of the functions of the thyroid gland commenced with the clinical observations of Caleb Parry (1786), Groves (1835), and Basedow (1840) on the condition we now designate exophthalmic goitre, and those of Curling (1850), Sir William Gull (1875), and Ord (1877) on the opposite condition of thyroid deficiency, to which Ord applied the term

"myxoedema." Schiff of Geneva had shown in 1856 that removal of the thyroid in dogs led to a fatal result; in 1882 A. and J. Reverdin of Geneva produced myxoedema in animals by total or partial thyroidectomy, and in 1883 Kocher of Bern reported that of 100 cases in which he had removed large goitrous tumours from human beings 30 developed the condition he described as "cachexia strumipriva," which he attributed to injuries of structures in the neck rather than to the loss of the thyroid. In the same year Sir Felix Semon suggested, at a meeting of the Clinical Society of London, that myxoedema, cachexia strumipriva, and cretinism were identical, and were due to loss of function of the thyroid gland. The Clinical Society of London thereupon appointed a commission to investigate this question, and selected Victor Horsley to undertake the experimental part of the work: he produced cachexia strumipriva in monkeys and other animals by removing the thyroid gland. In 1884 Schiff, repeating his previous experiments upon dogs, showed that death after thyroidectomy could be averted by transplanting the gland under the skin or into the peritoneal cavity, and von Eiselsberg proved the same to be true of the cat. In 1890 Horsley independently suggested thyroid grafting to arrest myxoedema in man; this suggestion was acted upon by several surgeons, especially Bettencourt and Serrano, who attributed the improvement following immediately upon operation to absorption of the juice of the transplanted gland. Thereupon Murray, in 1891, suggested that the regular administration of the thyroid secretion in the form of an extract of the gland would remove the symptoms of myxoedema; he prepared a glycerin extract of a sheep's thyroid and injected it hypodermically at intervals into a patient with myxoedema, all the symptoms of which rapidly disappeared. In the following year Howitz of Copenhagen, and Hector Mackenzie and Fox in this country, found that a similar good result could be obtained by oral administration of thyroid extract or of the raw fresh gland itself, and thus was inaugurated the wonderfully successful thyroid therapy of the present day.

The progress of physiology during the present century has been characterized by many new methods of study, by the greater attention devoted to human physiology, and by the enormous strides made in the physiology of nutrition. If we look back to the beginning of this century and compare the state of physiological knowledge then with that of the present day it is wonderful to contemplate the discoveries that have been made. The use of x rays for the examination of the function of the stomach and small intestines, developed first of all by Cannon for physiological purposes, had only just begun to be applied to the diagnosis of alimentary diseases. The role of proteins in nutrition was imperfectly understood and their chemical constitution was only a conjecture. Vitamins had not been heard of. Insulin was still a hypothetical substance. None of the active principles of the ductless glands had been synthesized and their mode of action was very incompletely known. Micro-methods for the biochemical examination of the blood and other body fluids were practically unknown. The buffering mechanisms of the blood were not dreamt of, and the close interplay between normal physiological functions such as secretion and respiration, and their part in the regulation of body neutrality, was not known. The relation of the capillary circulation to the production of shock is also a relatively recent discovery.

All these advances in knowledge, and many others that might be mentioned, have had their influence on surgery—directly, because they have improved methods of diagnosis and treatment, and indirectly on account of their influence on the attitude of the surgeon to his subject. It is impossible to deal in detail with each particular advancement which surgery owes to physiology, but a few examples may be mentioned.

Rickets.

This disease, responsible for a large number of the deformities with which surgeons have been called upon to deal, may be expected to disappear within the next decade, as a result of the discoveries which have been made on the influence of vitamins, and especially vitamin D, on nutrition. It is a matter of congratulation that the pioneer work of Hopkins on the discovery of vitamins, and of Mellanby on the dietetic factors which influence the development of rickets in dogs, was done in this country. In 1915 Mellanby showed that rickets was a "deficiency disease" due to absence from the diet of some unknown factor which controls the calcification of bone and the development of the teeth, and he thus foreshadowed the discovery of a fourth vitamin now known as "vitamin D"—the antirachitic vitamin. It was shown that rickets experimentally produced in animals

could be readily cured by administering cod-liver oil, and the same was known to be true of rickets in children. This knowledge was successfully utilized on a large scale in Vienna in 1919 for the treatment of children afflicted with rickets as a result of an insufficiency of fats in their diet during the great war, when, in the Mid-European countries, all available fats were deflected to the production of high explosives. It was there observed that rickets was much more easily cured in summer than in winter, and that exposure to the summer sunlight alone, even without the administration of cod-liver oil, could arrest the disease. Later the discovery was made that exposure to the ultra-violet rays from a carbon arc or a quartz mercury vapour lamp had the same beneficial effect as sunlight or as cod-liver oil; while, still later, irradiation of the body of the child or animal was proved to be unnecessary provided that the food be exposed to the ultra-violet rays prior to administration. Tests applied to the different constituents of the food indicated that only the fatty portion could be activated by ultra-violet irradiation, and by further elimination the essential factor concerned was finally shown to be "ergosterol"—one of the group of sterols usually associated in small amount in the human body with cholesterol, and found plentifully in yeasts and in the fungus ergot of rye, from which it was first isolated. On exposure to the ultra-violet rays ergosterol changes from a white crystalline substance to a pale yellow resinous material, which is the most potent in vitamin D content of any known body. It is estimated that 5 milligrams of this substance is the equivalent in antirachitic power of one litre of cod-liver oil, and the daily dose needed to prevent rickets is only a small fraction of a milligram. Upon the presence of ergosterol in the natural fats of the skin, and the production of vitamin D by the action thereon of the ultra-violet rays, depends the curative power of sunlight on rickets.

Irradiated ergosterol is now produced on a commercial scale by many of the large drug firms, under such names as "radiostol," "vigantol," etc., and by its substitution for cod-liver oil the preventive and curative action of the latter upon rickets can be obtained without the disadvantage of its taste, or of its tendency to upset digestion. This direct production of vitamin D is certainly the most important advance yet made in the chemistry of the vitamins, and has not only paved the way to a rational therapy of rickets, but, better still, has pointed out methods of prevention that should lead to its disappearance. Mild degrees of rickets are, unfortunately, still very prevalent, and in a recent report Sir George Newman states that as a result of the examination of nearly 1,000 children of 3 years of age in various parts of the country some manifestation of rickets was discovered in as high a percentage as 48.7. The time required for cure by the various methods of treating rickets is a question of some practical importance. At Alder Hey Hospital, Liverpool, Dr. Aidin (*Lancet*, February 4th, 1928) found that in severe cases treatment by antirachitic diet together with cod-liver oil effected a cure, as shown by radiological examination of the bones, in approximately fifteen weeks; additional treatment by exposure to the tungsten-cored carbon arc lamp shortened this period to nine weeks; while the further addition of irradiated cholesterol internally and the substitution of the quartz mercury vapour lamp for the tungsten carbon arc brought about a radiological cure in approximately five weeks. Not only has this new treatment of rickets—the administration of concentrated vitamin D—an apparent advantage in point of time, but its great convenience, its exactness of dosage, and its economy are all in its favour. Before its adoption on an extensive scale, however, much requires to be known as to the stability of the new preparations, their keeping properties under various conditions, the exact dosage required for the cure of human rickets, and the possible dangers of excessive dosage.

Blood Transfusion.

This, one of the most useful of our emergency surgical therapeutic measures, although first performed upon animals by Lower so long ago as 1666, and upon a youth of 15 years by Denys of Paris in 1667, was very little

practised until the present century. Thus was largely owing to the uncertainty of the outcome, the blood of one man not being always compatible with that of another, but sometimes reacting so that the corpuscles of the donor's blood are agglutinated by the serum of the recipient, and more or less rapidly destroyed; not only does the recipient then fail to receive any benefit from the transfusion, but injurious consequences may ensue varying from slight discomfort to sudden death. The physiological researches of Jansky in 1907 and of Moss in 1910 (in America) into the interaction of a large number of specimens of human blood led to the establishment of the four now well-known blood groups. The blood of individuals belonging to the same group may safely be transferred from one to another, and even if of different groups may still prove compatible under certain conditions of admixture now fully investigated. Simple means have been discovered of determining the group to which a person belongs, and consequently this valuable surgical procedure has been reintroduced on a sound physiological basis, while an increased knowledge of the phenomena of blood coagulation has evolved a relatively simple technique—the sodium citrate method—which has largely replaced the older one in which the blood vessels of the donor and recipient were directly connected. In the war it was not until the advent of the U.S.A. army medical officers in 1917 that blood transfusion was utilized on any large scale, but thereafter it proved invaluable as a means of combating haemorrhage and shock, both of which factors were usually associated with the extensive wounds of warfare. In the surgery of civil life blood transfusion is destined to play a steadily increasing part in the treatment of acute anaemia, whether due to haemorrhage alone, as in severe haematemesis from gastric or duodenal ulcer, or to secondary haemorrhage from an amputation stump; or whether associated with shock, as in severe industrial railway and motor-car accidents, and after serious surgical operations. In such emergencies there can be no question as to its immediate life-saving value. Transfusion has also proved of great benefit in the more slowly developing anaemia of repeated small haemorrhages, such as occur in ulcers and malignant growths of the stomach and colon, and has frequently enabled a radical surgical operation, otherwise quite impossible, to be safely undertaken. In jaundice, purpura, haemophilia, and other haemorrhagic diseases, transfusion, in addition to replacing the blood actually lost, has a beneficial effect upon the tendency to haemorrhage; in pernicious anaemia repeated transfusions, though not a cure for the disease, may prolong life for months or even years; in pyogenic infections transfusions of blood from a donor, who himself is first actively immunized ("immuno-transfusion"), has met with some success and is at present on its trial; whilst in other toxæmias and in other directions blood transfusion is being increasingly utilized.

Insulin.

Although the isolation of insulin and its preparation in a suitable form, standardized for therapeutic use, is a triumph of physiology which finds its greatest use to the physician in the treatment of diabetes, yet it has not been without its value to the surgeon. Diabetic patients require surgical attention proportionately much more frequently than non-diabetics, or than sufferers from other chronic diseases. Thus Fitz found that 14 per cent. of 386 diabetics consecutively treated at the Massachusetts General Hospital required surgical intervention, chiefly on account of the frequent occurrence of carbuncle and of gangrene. Prior to the introduction of insulin a high mortality attended surgical operations in diabetes, mainly owing to slow healing of the tissues, to their increased liability to infection, and to the frequent development of post-operative coma; insulin administration, together with precision in diet, has so completely transformed the surgical outlook that, as reported from the Mayo Clinic in 1926, no patient is now refused any necessary operation because of diabetes, and the mortality of operations upon diabetics has been reduced to that in cases without this complication. It seems likely that in the future, with a better knowledge of

the part played by insulin in carbohydrate metabolism, it may find other uses. Its value in furthering the deposition of glycogen has already been applied to the improvement of the functional activity of the liver, and in cases of inanition which have to be operated upon it may be of value in rapidly inducing a better nutritive condition of body tissues; while the combination of glucose intravenously with insulin subcutaneously has proved of considerable value in the treatment of shock, creating an immediate supply of energy from the rapid oxidation of the glucose by insulin.

Assessment of Renal Function.

It is principally to the painstaking and persevering work of the American biochemist Folin that we owe the modern micro methods of blood analysis whereby, using only a few cubic centimetres of blood, all the important constituents can be accurately determined. These methods have been particularly helpful in cases where prostatectomy is contemplated and where it is essential to know to what extent the excretory functions of the kidneys have been already adversely affected by back-pressure from the prostatic obstruction, as indicated by the abnormal retention in the blood of urea, uric acid, creatinin, and other waste products to an extent varying directly with the degree of renal derangement. It cannot, in fact, be too strongly stressed that the operative risks of prostatectomy are concerned infinitely more with the condition of the kidneys than of the prostate, and that by delaying the major operation until the renal functions have been improved by the relief from "back-pressure" afforded by adequate preliminary drainage of the bladder—either by the indwelling catheter or by suprapubic cystostomy—the dangers attending the removal of the prostate can be very materially diminished. Biochemists, by means of their tests of renal functional capacity, have enabled surgeons to estimate the power of the kidneys to withstand surgical intervention with a degree of accuracy that is truly remarkable. Would that the same could be said of the liver, and that we could "size up" the functional state of that organ as simply and as correctly as we can that of the kidneys. So manifold and varied, however, are the functions of the liver, and so diverse the directions in which deranged hepatic function may become clinically manifest, that any reliable estimation thereof must necessarily involve more extensive and more complicated procedures than in the case of the kidneys.

Of other methods of applied physiology to which the surgeon is indebted, mention may be made of the use of fractional gastric analysis for investigation of the activity, both digestive and motor, of the stomach; the duodenal tube for the collection and examination of bile; estimation of the basal metabolism as a guide to over- and under-activity of the thyroid and pituitary glands, and to the nature of the operative procedures to be undertaken in connexion therewith; determination of the carbon dioxide combining power of the blood and its relation to the diagnosis of those conditions of acidosis and alkalosis that occasionally complicate surgical procedures; and the examination of the red blood corpuscles for "fragility" in cases of splenic enlargement, as in haemolytic jaundice.

In the past a large proportion of the discoveries of physiology has been the outcome of experiments upon animals, conducted in physiological laboratories, while the wide field for the investigation of its problems offered by the hospital wards and operating theatres has been comparatively little utilized. For the elucidation of many points man himself possesses several advantages over the lower animals as a subject of investigation, and a more active encouragement of clinical research in human physiology is one of the prominent needs of to-day. In Manchester the University professor of physiology has been placed along with his colleagues in anatomy, physics, and pharmacology, upon the consulting staff of the Royal Infirmary, so that the closest possible connexion is maintained between these ancillary sciences and the clinical aspects of medicine and surgery.

Pregnant with promise, too, is the recent extension of physiological research to the whole field of human activity. Laboratory investigations have taught us much of the

physical and chemical workings of the individual systems of the human body, and have supplied us with various measures by which these can be tested. But of the workings of the human machine as a whole under the varying conditions and stresses of industrial and other forms of activity comparatively little was known. Early in the war it was recognized that the methods of medical examination of recruits then in vogue were far from satisfactory, and their inefficiency was frequently shown up on the parade ground and in the training camps. Especially was this so in the case of individuals in the Royal Air Force, where it was soon recognized that perfectly "sound" men, in the usually accepted medical sense, might nevertheless be quite unfitted to control an aeroplane. New and more delicate tests were required of the functional activity of the various systems, especially the visual, circulatory, and nervous systems, and of their quickness of response to the constantly changing conditions met with in flying. The medical officers of the Royal Air Force have shown most praiseworthy ingenuity in devising methods for the more efficient testing of the body functions, and have given a great impetus to the study of the healthy human machine at work under conditions hitherto unknown. In the field of industry it is becoming more generally recognized that the test of health is the capacity to perform effective work, and researches are constantly being made into the effects of environmental factors—for example, fatigue, monotony, noise, high illumination—upon the productive efficiency of the industrial worker. It has been shown that the distribution of industrial accidents amongst workers exposed to similar conditions of risk is not a mere matter of chance, but that each has an individual proneness to accident which can be fairly exactly estimated by testing the rapidity and accuracy with which he reacts to certain visual, auditory, and tactile stimuli. Though much still remains to be accomplished, the valuable information thus acquired has already brought about vast improvements in working conditions in many of our industries, and in the standard of health and the productive capacity of those employed therein.

Of modern surgery's debt to the other ancillary sciences that to bacteriology is assuredly the most fundamental, since it was Pasteur's discovery that fermentation and putrefaction were caused by minute living organisms and were, therefore, vital and not merely chemical pro-

cesses, as hitherto believed, that led Lister to his great conception of the antiseptic treatment of that putrefaction then found in almost all wounds—a conception which constitutes, as we have seen, the very starting point of modern surgery. Time permits me merely to mention other advances in bacteriology: the detection of the causative germs of almost all the infective diseases; the enunciation of the great principles of immunity, both "active" and "passive"; the preparation of vaccines and of antitoxic serums and their use in the prevention and treatment of bacterial infections; the therapy of systemic infections by the intravenous introduction of chemical antiseptics resulting, among other notable gains, in that brilliant conquest of the former scourge of syphilis that has been achieved within the present century—all of which constitute milestones along the highway of bacteriology's triumphal progress.

Nor have I time to refer to the great help that modern surgery has received from research workers in anatomy, pathology, and pharmacology, valuable as their contributions have been; nor yet to more general sources of assistance such as the greatly improved means of rapid intercommunication—the telephone, the wireless—and of rapid transport—the motor-car, the aeroplane—factors which have so materially facilitated the prompt application of surgical relief in cases of emergency, whether on land or at sea.

I trust, however, that enough has been said to indicate that modern surgery, with the aid of its allies, has made and is still making great progress towards that end we all so fervently desire—the prevention of those abnormal conditions, the late results of which to-day necessitate so much surgical attention of a destructive rather than a constructive character. Much yet remains to be done, and the natural sciences must continue to advance, each ready to assist and to accept assistance from its fellows, each along its own special path yet all in mutual friendly alliance working for the common good, all in zealous pursuit of that goal, unattainable though it must ever remain, that will-o'-the-wisp of perfect knowledge and complete understanding. In so doing they will but follow the precept and the spirit of that motto upon the crest of our beloved University, in whose venerable precincts this great Association will to-morrow enter upon its full scientific programme, and of which we in this city are all so intensely proud: "Arduus ad solem"—"leaping upwards to the sunshine"—"ever striving towards the very highest."

PHYSIOLOGY THE BASIS OF TREATMENT.*

BY

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THE ultimate aim of medicine is the prevention or cure of disease: this practical aspect so far dominates all others that it is often referred to as the healing art; indeed, it is difficult to think of medicine apart from treatment.

The term "physiology" is usually used to designate the science of function, whether it is studied in broad outline and dealing with the mechanism of action or as the physico-chemical mechanisms leading up to this action. Disease means the unusual functioning of tissues which may be the result of accident, hereditary weakness, or parasitic organisms. Generally it is wrong to speak of this as malfunctioning: the unusual functioning is physiological and perhaps the best for the organism under the unusual conditions. The science of medicine, then, is nothing more than trained and organized common sense based on physiology. It is still usual to speak of it as an inexact science; this is obviously wrong, since medicine uses the same methods as every other science, and the results of observation are as definite as those of the chemist or physicist; although it is true that, in the complexity of

the problem with which the physician may have to deal, all the conditions of importance may not be known, and the results of an investigation, though correct for the conditions under which it is undertaken, may be misleading.

When the sciences of physiology and pathology a century ago passed from the realms of natural history to deduction and experiment, they naturally attracted the more original and eager minds in medicine, and the text of the writings of the nineteenth century deals with changes in structure and function. Treatment became neglected, the old shibboleths and rituals of treatment which had held sway for centuries were discarded, and there was nothing with which to replace them. In the middle of the last century S. Skoda and K. Rokitsansky perfected a system of physical diagnosis which has had a practical bearing on medicine ever since. Skoda made many experiments with drugs on the patient without any expectation of producing benefit; the patients were not improved and Skoda thought it mattered little how the patient was treated. Scientific medicine looked askance at treatment; textbooks spent many pages in describing the symptoms, diagnosis, and pathology of disease, but two or three lines dismissed the treatment: and even in our times the "scientific" physician is apt to be a diagnostician rather than a healer. The study of disease as an entity was the object aimed at, and a complete case was one which went to autopsy. This state of affairs was unavoidable; there was no specific treatment, there was no science of treatment, for such a science could only come into existence when physiology and pathology had reached some degree of

* Abstract of Presidential Address delivered on July 24th at Capetown before the Section of Physiology, British Association.