

the emphasis of a period is on morphologic studies, the corresponding subjects may well receive more attention; when, on the other hand, activity is more manifest in studies of function, there may be a modification of the curriculum to some extent in favor of the subjects that deal with function. A notable example of a wise dislocation in the curriculum is the lessened amount of time now given to materia medica since the necessity for a training in pharmacology has arisen.

I am inclined to believe that we could make a real advance in medical education if we reduced to a large extent the amount of time given to obligatory courses in all the preclinical and clinical subjects, and largely increased the amount of time that can be given to optional courses, to reading in libraries, to conversation, to reflection and to recreation. With good will on the part of the professors, with a better selection and organization of the general courses than is now prevalent, it would be possible, I believe, (1) to give an excellent general training in all the preclinical sciences, (2) to give opportunity for participation by each student in several optional courses on topics that particularly appeal to his interest, or that are especially suited to develop his talent, and (3) to leave some time, so sadly lacking now, for independent reading, for meditation, and for exercise in the open air—and this without extending the time now given to the preclinical work. I am sure there must be something wrong, however, with a disposition of the time and activities of medical students that sometimes results in a morbidity of 10 per cent. of a class from tuberculosis, even when on admission to the medical school, the members of the class have seemed, on physical examination, to be in good health.

In a few words, then, when considering the relation of the preclinical laboratory courses to the work of the clinical years, we should in my opinion assent to the following principles:

1. In each department, both teaching and original investigation should be represented.

2. It is the duty of the teachers of each subject to arrange the courses so as to give the most desirable training to men who are later to be medical practitioners, while at the same time providing for the education of some men that will not go into practice.

3. In developing the courses in the single preclinical sciences, regard for the direct utilitarian bearing of the subject on clinical work does not justify the teacher in neglecting the inculcation of the general principles of his science so that it may be understood as a harmonious whole, or the training in such technical methods as are necessary for the investigative work of the science for its own sake.

4. Whereas it is desirable that the student shall, on entering the work of the clinical years, bring with him a certain store of facts accumulated during his preclinical studies, it is even more important that he shall enter the clinic with his mind educated to observe accurately, to experiment in order to increase the accuracy of its observations, to sift critically, to think independently, to arrange facts in logical sequence, and to desire to act rationally—in other words, with a mind habituated to the methods of science. Finally, in making periodical readjustments of our curriculums, we shall need to vary the amount and kind of instruction in each clinical science in some degree according to the trend of the productiveness of the period, and we

shall be wise, I believe, if we reduce the obligatory work in all subjects to the minimum consistent with an adequate general presentation of principles and technic, providing optional courses that may be taken by those that desire them, and leaving some time free for reading, for reflection and for open-air pleasures.

PRINCIPLES AND EXPERIMENTS IN MEDICAL EDUCATION *

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James Russell Wallace once said in substance that the twentieth century added to human knowledge more than all its predecessors, but had done less than any other to make its knowledge available for human needs.

As the mother of the sciences and the chief instrument for the subordination of physical evil, this charge was laid chiefly at the door of medicine. It cannot be doubted that the charge was valid when Wallace made it, and probably today it remains virtually unanswered. There is, however, an obvious reason for this situation. The nineteenth century witnessed the gathering of practically all of the intimate and effective knowledge of physics and biology. During the period of the accumulation of this vast knowledge, it could hardly be expected that its practical application could keep pace with the rapid growth in so many directions. The great dilemma in medical activities today is the difficulty of maintaining a proper balance between the interests of pure science and research and the practical applications of medical knowledge.

A hasty retrospect will reveal how rapid the progress and how broad the expansion of medicine has been. Anatomy, the oldest of the medical sciences, entered the nineteenth century with considerable familiarity with the gross structure and even of the development of the human body, but histology and embryology experienced their modern growth in the latter half of this period. Huxley conceived the germ layer theory in 1860, Killiger systematized histology in 1870, and nuclear fusion in fertilization was not discovered by the Hertwigs until 1880. Apparently the most accessible and clearly definable domain in medical research anatomy in the last few decades has enjoyed an extensive and most significant transformation in becoming comparative and experimental. It has thus changed from a descriptive to an analytic science. Today in the several departments of gross human and comparative anatomy, histology, embryology and experimental morphology it easily maintains its place as the backbone of medical science.

Modern medicine is just about sixty-five years old. It began in 1853 when Virchow formulated the doctrine of cellular pathology. As late as 1833, Lobstein recast the ancient theory of the origin of cells from plastic lymph. In 1831, Schleiden discovered the vegetable cell; in 1833, Robert Brown described the cell nucleus; in 1838, Schwann identified the structure of plant and animal tissues; but not until 1849 did

* Read in a symposium on the "Relation of the Laboratory Courses to the Work of the Clinical Years," at the Twelfth Annual Conference of the Council on Medical Education of the American Medical Association, Chicago, Feb. 7, 1916; abstract of discussion, Society Proceedings, THE JOURNAL A. M. A., Feb. 19, 1916, p. 596.

Cruveilhier venture finally to deny all validity to the blastema theory of tissue origin.

On the basis of cellular pathology, it became possible to formulate reasonably correct conceptions of what disease does in the body; and the vast additions to the knowledge of pathologic anatomy, and histology accumulated during the last sixty years, have gained for this subject universal recognition as the foundation stone of internal medicine. More than any other of the medical sciences, it separates medicine from the medical cults.

Guided by sound morphologic conceptions, physiology made rapid progress, beginning about the same period. In 1856, Claude Bernard's memoirs on the functions of the pancreas marked the beginning of experimental physiology. From a long line of famous contributors covering an ever widening field, we have today fairly accurate knowledge of the normal and disturbed functions of the body.

Chemistry long applied in a crude way to the problems of medicine became direct in its objects and fruitful in its results when its tasks were clearly set by pathology and physiology. Woehler connected the inorganic with the organic world by making urea synthetically in 1828. Liebig recognized the three classes of foodstuffs in 1846. Today the methods of organic and inorganic chemistry throw light on the intimate nature of physiologic processes, and this exact science has been of indispensable help in the development of pharmacology, bacteriology and general biology. In fact, the conceptions of vital processes tend more and more to be formulated in terms of chemistry, inorganic, organic, physical and physiologic.

Pasteur demolished the doctrine of spontaneous generation in 1861, and from his work dates the commencement of bacteriology and the germ theory of disease. Modern surgery is also its direct descendent. Through the methods of Robert Koch, we now know rather intimately the identity, life characters and mode of action of most of the bacterial causes of disease. As a direct outgrowth of bacteriology, there came into existence the science of immunology, in which the therapeutic triumphs of Behring and Roux in diphtheria were the first fruits. More recently, out of the study of immunity mechanisms has arisen the vigorous science of serology, which employs the methods of chemistry and physical chemistry over a wide range of problems, and has carried the elucidation of many phenomena of disease far more deeply than was possible or conceivable before its advent.

The first pharmacologic laboratory was established by Buchheim in 1856. Pharmacology may be said to have inherited the most difficult of all the labors of modern science. To cleanse the Augean stables of the accumulations of ancient medicines, to stem the ever increasing tide of empiric remedies, to wait on clinical medicine for its problems and on physiology and chemistry for its methods, have been some of the handicaps of this science, in spite of which its contributions form a sheet anchor for intelligent therapeutics.

Internal medicine has always had its own problems, and many of them antedate the cellular pathology; but few of its products of earlier date have escaped transformation at the hands of the modern sciences.

Clinical medicine has catalogued and superficially described the concrete problems of disease and turned them over for solution to the appropriate sciences. It receives in return the burden of applying the new

knowledge as it is gained, and it has been overwhelmed by the task. It has had to resort to an elaborate subdivision of the field, and is now comprised of very numerous medical specialties covering different systems and organs, or even single diseases.

Legal medicine it has definitely set apart; but legal medicine thus orphaned has taken good care of itself, and through Taylor, Tidy, Maschka, Hoffman and a long line of notable students it has come to form one of the most effective, as also the most exact, of the applied branches of medicine. It is true that many American communities get along without any competent aid from modern forensic medicine, but only at the expense of public morality and safety.

Preventive medicine may be said almost to have outgrown its parent and certainly to have oustripped it in significant accomplishments. In effective form it is certainly a modern branch of applied medicine. In infectious diseases it was made possible by bacteriology, and in other fields it grew out of physiology and chemistry, and it employs all these sciences and engineering and other departments of physical science as well. It presents by far the broadest front of medicine, coming in contact with nearly all human interests and activities, and merging through the various departments of hygiene with criminology, sociology, political economy and the science of government. Its relation to military science and the general problem of national preparedness deserves especial mention at this time.

I am not attempting to sketch the history of medicine. I am merely calling the roll of the present existing departments of medical knowledge with a hasty glance at each for identification, and I am doing it for the purpose of expressing a point of view which would seem to be the logical one for the recognition of the principles of medical education. You may call it the laboratory point of view because it emphasizes certain subjects that are pursued chiefly in laboratories, but I prefer to call it the historical point of view.

It puts the care of the sick in a prominent position, but yet in a just relation to those other branches of knowledge which have made it possible to care for them at all and which offer a hope that we may sometime care for them better.

What has been the attitude of conservative medical educators during this period of sixty-five years? There is only one answer to this question. They have considered paramount the interests of medical progress. They have placed the highest value on all those influences which tend to support and develop the medical sciences. This position also has been maintained unassailed up to very recent years. During the period when the course of medical study occupied two or three years, 70 or 80 per cent. of the time was devoted to the fundamentals of medicine. Anatomy was by far the most prominent subject in the curriculum. The student saw little or nothing of practical medicine. In the last decade, with the addition of the fourth year, a systematic and comparatively successful effort has been made to enlarge the scope and improve the quality of clinical training, and some of the second, a large part of the third and nearly all of the fourth years are devoted to applied medicine and the actual practice of the medical calling. The result has been most beneficial. The student acquires as much or more theoretical knowledge than he had before, and he is able to apply that knowledge at the right time and in the right way at the bedside. I judge that the present medical

graduate is not open to the charge of Wallace that his particular knowledge is not available for practical needs. On the contrary, the clever student is so well equipped for practice that his services are usually in demand from the moment of graduation. He is by no means an experienced physician, he is not a competent surgeon; but he has delivered his half dozen obstetric cases, and in his hospital training he has watched the course, assisted in the diagnosis, applied the treatment, attended the necropsy, and listened to authoritative interpretations and discussions, in most of the common and many of the rare diseases that the general practitioner meets. Of the 4,000 hours of his medical course, he has devoted on a calculated average over 2,000 to these attainments.

This is genuine and effective clinical training, and its accomplishment has been the most conspicuous recent advance in medical education, at least in America. I think that laboratory men everywhere have witnessed this change with satisfaction and offered their hearty congratulations to their clinical colleagues.

Encouraged by the success of the new plan and impressed by the undoubted advantage of further extending the practical clinical training of medical students, it has been proposed to add to the required curriculum a fifth clinical year to be spent by the student as a junior intern in the service of an approved hospital.

I have elsewhere pointed out some objections to this plan. These objections seem to me serious and fundamental. They are briefly as follows:

1. It is a tactical mistake for university trustees to relinquish control of any essential part of medical education. It is an illogical step and a dangerous precedent to encourage state legislatures to dictate to university faculties how they shall conduct medical education, and it is unfortunate that any political influence should have been introduced into this matter.

2. It is an unsound educational principle to replace systematic instruction by members of a university faculty for training by hospital attending physicians with the routine material occurring in hospitals.

3. The average hospital is quite unsuited for medical education. Hospitals should first be standardized before students are by law forced into them.

4. The introduction of a fifth purely clinical year raises an additional bar against the choice of a career in scientific medicine.

5. The clinical year unbalances the curriculum by placing excessive emphasis on clinical training while subordinating the fundamental sciences and general medical knowledge. It turns out practitioners instead of educated physicians.

The aspect which the fifth year is beginning to take in some institutions of the highest grade meets some of these objections to its original form. It seems to be generally agreed that the year may safely be spent only in a hospital controlled by a medical school. In some notable cases the work of the year is systematically outlined and placed at least nominally under university officers. This plan is quite different from that of turning the student over to the hospital as a junior intern.

There are still further alterations in the plan of clinical training which virtually emasculate the scheme of pure clinical training. Thus Leland Stanford University requires a year in a hospital or in some other

work. The qualifications of the hospital are specified, but the "other work" is not described, except that the student must write a thesis. The University of Chicago prescribes the conditions of the clinical work, and offers an option of research in any department of the medical school. Both of these plans relieve the harshness of the order that the student must enter a hospital if he wants to practice medicine.

On the other hand, the law of Pennsylvania, and that recently passed in New Jersey, flatly state that a year of service in a general hospital is required for the licensure to practice medicine.

Thus in regard to the very important matter of clinical training and the licensure to practice, there are at least three different conditions existing in prominent medical centers in this country. In the majority of eastern states the licensure to practice is granted on the recommendation of the medical school after four years of systematic training prescribed by the school. In some states the schools prescribe a fifth year either in a hospital under university auspices or in any approved advanced study. In a few states the student is required to enter a general hospital and serve as a junior intern.

The last scheme I can only regard as an injudicious experiment in medical education. For the sake of raising the average dexterity of the lowest grade of student, it ignores the claims of broad general education as a whole. It commits the state to the training of practitioners instead of the education of physicians. I am well aware of the gross incompetency of a large body of medical students in many sections of the country to practice medicine. For these the hospital year will be an advantage. It will not be wasted on any student, but it is a measure designed to deal with the lower strata of student society, and it is not the best available method of securing the desired results. It is open to all the objections which have been enumerated above. It will turn out smart young doctors well acquainted with the present vogue of endless clinical tests and methods they imperfectly understand, rather successful in practice, but, if possessed of intellectual honesty and personal ambition, ready to return to their alma mater after four or five years and beg the privilege of "brushing up." They are doing it now by hundreds, until the postgraduate instructors often outnumber the undergraduate students.

Fortunately there are indications that this scheme will not be adopted by many other states in which a reasonable circumspection precedes action in matters of such great importance.

The second plan of introducing a fifth year of advanced study in clinical or other fields is quite a different matter, and contains the elements of progress in the right direction. It may be assumed that five years of medical study are needed today for the education of physicians. This period has long been required in Europe, and its need has long been recognized in America. But when the fifth year is adopted, great care should be used in its disposal. From the historical point of view of the larger interests of medicine, I would venture to suggest certain considerations which may safely govern the disposition of this valuable time.

In the first place, it may well be asked if the fifth year may not permit the readjustment of the crowded curriculum of the first two years. Into this brief

period has been forced nearly all the theoretical training in the underlying medical sciences, as well as preliminary clinical work, so that few instructors feel satisfied that students now secure a real knowledge of these subjects. Speaking for pathology, I can say that the best present courses in this subject are on the whole elementary and abbreviated. Medical students do not adequately learn what disease does in the body. In most courses in pathology some important diseases are not even mentioned.

I am one of those who believe that a surgeon should know the natural history of the different forms of epidermoid cancer before he learns how to cut the cancers out, and that the physician should know the theories of the pathogenesis of rickets before he treats and advises such patients. The same standards of value apply to the instruction in other basic branches of pure and applied medical science. They need more time.

There are also several branches of science which are of great importance in modern practical medicine, are now presented imperfectly or not at all, and which may well receive due attention in a remodeled curriculum. Of these may be mentioned physical chemistry, medical physics, immunology, serology and chemical pathology. Such changes would meet some of the demands of the newer branches of knowledge on which the progress of medicine chiefly depends and with which the educated physician should be reasonably familiar.

In the latter half of the curriculum some specialization may be permitted toward the career the student may choose, but a broad education requires a thorough grounding in the principles of the theory and practice of medicine and surgery. Laboratory men are too often unfamiliar with the interests and problems of medicine, and their usefulness in medical faculties and in research is thereby curtailed. On the other hand, practitioners are hurried into practical exercises with a smattering of theoretical knowledge which they imperfectly apply ever afterward. The only comment I venture to make regarding present methods of undergraduate clinical training is to suggest that clinical clerkships are difficult to manage in a systematic course of instruction, and that there is danger of anticipating the work a hospital intern does under more favorable conditions. The main problem is the disposition of the fifth year, especially for that great majority which elects to practice medicine. In conversation with many colleagues I find a widespread feeling that this year should be made a year of university instruction and not a year of service in a hospital. Unless agreement on this principle can be reached, the fifth year becomes a matter of quite secondary interest to the medical educator. To follow a hospital attending physician about the wards and see what he does in his daily routine may enable the student to pick up many practical points, but it is not medical education. Nor will it suffice to exact a promise that the attending physicians will undertake the duty of giving adequate instruction to the interns. The attending physician is a busy man, and the best of his disquisitions on rounds are inferior to a systematic discussion prepared for the particular purpose of instructing advanced students.

The student can do much better by spending a year with carefully prepared clinical courses given by expert teachers in European hospitals, as many of our stu-

dents have done. We must do at least as well as they if we are to hold our students and develop effective advanced clinical instruction. A corps of competent university instructors of the type of *privat docenti* is needed to conduct this work. It should be one of their chief occupations, and an essential preliminary to their advancement to more prominent positions in the medical faculty. It has often been said that the training of students is much easier than the development of a faculty.

Should the work of the fifth year be conducted in a hospital? Certainly access to patients is necessary, and the observation of all the phenomena of disease that can be obtained will be of great value. Yet I believe the time thus spent should be limited and not devoted to routine history taking, colored photography, blood and urine examinations, and the keeping of records. The student should not be made a hospital servant, but should spend his time in the hospital in the presence of clinical material, in seminars on specific topics, prepared for him by his instructors. The hospital laboratory may develop his technical competency to a certain extent, and acquaint him with the principles, sources of error, and necessary limitations of laboratory diagnostic tests. He will then escape that implicit confidence which the average practitioner places in these mechanical methods of diagnosis.

The hospital morgue can offer him brief and significant insight into the effects of disease and the pathogenesis of symptoms. At the necropsy table he will learn some of the deficiencies of medical diagnosis and surgical procedure, and he will not grow up with personal conceit or a fancy for hero worship.

Rather than remain in a single hospital, the student should enjoy brief terms of instruction in several institutions, where he may obtain first hand knowledge of special fields, as pediatrics, contagious diseases, tuberculosis, cancer and insanity. Periods of three or four weeks spent in five or six such hospitals would give the general practitioner some real knowledge of the diseases which are chiefly to occupy him in practice, and which he cannot get by continuous residence in a single general hospital. The prospective surgeon might well replace the present initiation on the human patient by learning surgical technic on lower animals. His particular needs could be met by devoting special attention to the various subdepartments of surgery. To what extent specialization should be permitted in the fifth year I am not prepared to say, but think that in general we are inclined to exercise too minute supervision over the natural tendencies of well trained students.

So much opportunity for effective clinical training lies in these directions that it is difficult to find any defense of the scheme of turning the student over to the service of a hospital as junior intern.

I am a firm believer in the value of a comprehensive knowledge of disease, descriptive and theoretical, as obtained from medical literature, and I think the advanced student should spend all his evenings in the library. He should be required to search the literature for observations and interpretations of what he sees in the wards, and should report his results in good English. American medical literature is rapidly improving in quality and scope, but it will not reach its proper development until the better class of students are trained to activity in this field, and to develop a critical knowledge of good literature. It is said that

by far the largest circulation among medical periodicals in this country with one exception is enjoyed by certain semimedical journals whose standards of accuracy and possibly of ethics are questionable. Yet it is a principle of journalism not to create but to cater to the current tastes. Who is responsible for the taste for such literature. It is certainly the medical schools and possibly not always those of the lower class.

The production of an original thesis is included in all schemes of advanced clinical instruction. It should be made a genuine test of the student's ability in clinical observation and laboratory procedure, of his knowledge of literature, and of his ability to solve a problem, and should occupy quite as much of his time as his attendance in the hospital. It is hardly necessary to expand the point that unless the student has had some experience in solving a problem he will stand resourceless before the numerous clinical problems that confront him in practice. The young practitioner may be so fortunate as to have seen as a student just the same peculiar condition that confronts him in his first patient. Far more often he will have to depend on his general knowledge of disease, of medical sciences and how to apply them, and on his previous training in the solution of problems.

Finally, the fifth year may well give opportunity for the introduction of substantial courses in preventive medicine, hygiene, history of medicine, forensic medicine, and other fields in which medical knowledge comes into touch with the needs of modern society.

There is nothing new in the plan thus roughly outlined. It embodies the suggestions that have long been discussed and approved in many circles and have taken form as the needs in particular fields have become more concrete. It is based on the principle of the comprehensive education of physicians. It aims to provide the student with an effective body of practical information, with a genuine knowledge of the central medical sciences and with some competence in and sympathy for all branches of medical activity. It is not an intensely practical scheme. On the contrary, it frankly emphasizes theoretical scholarship. A natural deficiency of common sense it will not make good, and the mature judgment of the old practitioner will still be the reward of experience. Yet very few men will pass through five such years unfit to practice medicine.

I very much doubt if any body of practitioners with such theoretical training would fall into the blunder recently witnessed in one of our states of requiring by law a negative Wassermann test as a condition of marriage. Here is an excellent example of the difference between an educated physician and the practically overtrained man who falls a ready victim to medical absurdities.

An ideal surgeon was Frank Hartley, who could tell every pathologic condition occurring from the skin to the bone marrow in any part of the body. He knew these conditions in the literature and he knew them in the flesh. He was a scholarly surgical pathologist, like Billroth, and at the same time a master of surgical technic, while directing his operative ambitions chiefly to the mucous membranes.

An ideal physician was Francis Delafield, who first learned pathologic anatomy and learned it thoroughly by years of observation at the necropsy table, who interpreted his findings by a superb histologic technic, read clinical symptoms in terms of structural lesions, left his mark on the principles of general and

the applications of special pathology, and then went out into practice and developed a systematized encyclopedic knowledge of the natural history of disease.

These men were exponents of a broadly conceived and faithfully executed educational plan, and they were some of its products.

We cannot do more and must not do less than bend our students in these directions, which are in accord with the best tendencies of the profession.

The historical development of medicine emphasizes the responsibility of medical education of today for the medical progress of tomorrow. On the roll-call of the present existing departments of medical knowledge, all must find a place.

A PROPOSED UNDERGRADUATE COURSE IN CLINICAL PHYSIOLOGY*

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It must, I think, be conceded that the average general practitioner of medicine knows far too little of the science of physiology, and has not the habit of looking at his patients from the physiologic point of view. He sees the normal man or woman hardly more than does the layman. The bodily condition that is before him in his professional life is a derangement, and it is the derangement that he has been taught to focus his interest on. When, too, he thinks of a deranged organ, it is the anatomic picture of it that is foremost in his mind, and not the deranged function. But his problem is really one of dynamics, not of statics, and the thought that should always be paramount, I contend, is that he is dealing with a derangement of a physiologic mechanism—a machine of inconceivable complexity has got out of order and it is his business to locate and determine the nature of the trouble and set the machine right. His problem all through is one that, when properly attacked, requires a keen knowledge of what the machine is capable of doing when in good order. Yet it is surprising to realize how little in detail the average general practitioner knows of this, and how little he analyzes his pathologic problems from the physiologic standpoint.

If this be conceded, how can it be remedied? Not, I think, by a change in existing courses in physiology. One of the obvious prominent features of the improvement that has taken place in medical education in the last quarter of a century is the reform in the teaching of physiology, and yet with all the professional physiologists, the physiologic laboratories and the required courses of practical work therein, the physiologic millennium, to which some of the most sanguine of us looked forward a quarter of a century ago, that state when the physiologic point of view will be paramount among clinicians has not yet come. Undoubtedly existing courses in physiology are capable of improvement. From the large mass of material constituting the science, a better selection of topics to be considered by the instructor and of experiments to be performed by the students may often be made. While maintain-

* Read in a symposium on the "Relation of the Laboratory Courses to the Work of the Clinical Years," at the Twelfth Annual Conference of the Council on Medical Education of the American Medical Association, Chicago, Feb. 7, 1916; abstract of discussion, Society Proceedings, THE JOURNAL A. M. A., Feb. 19, 1916, p. 596.