defined the value of sound public health policies to industry, commerce, government and society. Moreover, no one has presented more clearly the attractiveness of the possibilities of public health service. He has been a constant advocate of the importance of providing public health with a background of pure science, chemistry, physics, biology, bacteriology, as well as of utilizing every increment of knowledge turned up in the fields of economics, sociology, psychology, and the like. He has even gone so far as to advocate that many public health workers might well be sociologists, chemists, psychologists, and what not.

The Flexner report in 1910 showed Harvard to possess one of the most richly endowed medical schools of the day. During the succeeding years the Medical School has borne its rightful share of responsibility for being in the vanguard. The impact of science on medicine placed a new responsibility for the training of doctors upon the university as a whole. The coordination of the clinical and the laboratory staff has been no easier at Harvard than it has been at other institutions. From the very nature of the case the clinical man, with his laboratory material in the form of living human beings, has operated under somewhat different pressures than have prevailed in other laboratories. Few persons recognize the difficulty that clinical men have found in adjusting themselves to the academic traditions of a university. Dean Edsall has been conscious of this problem throughout his entire administration. He has made notable progress in the coordination of the clinical and the laboratory phases of medical education, not alone through the capitalization of laboratory opportunities in the various hospitals; the clinical work has been illumined by the laboratory work in Harvard College as well as in the laboratories of the Medical School itself. The complexity of the administrative problems of a medical school is not fully realized: how to utilize leadership wherever it may be found; how to encourage brilliance in unexpected places; how to remain sufficiently unconventional to give free sway to new ideas. The answers to these questions baffle every dean, but in addition to these marginal activities there is the constant necessity for maintaining the school as a going concern. The successful medical administrator has been very rare. Dean Edsall has been able to succeed in an exceptional degree. In addition to his immediate responsibilities he has associated himself closely with the leading men in this country and Europe who have similar interests. To those of us who believe in the importance of great personalities wherever found in an educational program, it is heartening to note that the new president of Harvard is committed to the policy of filling vacancies with men of promise and distinction. With such a tradition and such a policy we may expect soundness of scholarship, research in keeping with the reputation of the university, clinical skill equal to the best that is known, recognition of essential elements in a program of preventive medicine and public health education that expresses the best that can be achieved within the limits of our social, economic and political organization.

THE DEVELOPMENT OF CLINICAL SUBJECTS AS CONTRIBUTING TO UNIVERSITY WORK

By Dr. EUGENE J. DuBOIS

PROFESSOR OF MEDICINE, CORNELL UNIVERSITY MEDICAL COLLEGE; MEDICAL DIRECTOR, RUSSELL SAGE INSTITUTE OF PATHOLOGY

IT is a great personal pleasure to me that I am permitted to take part in this afternoon's tribute to Dr. Edsall. It so happens that my own interest in research was largely stimulated by Dr. Edsall, something of which he has been totally unaware. The particular medical school that I attended seemed to have little interest in anything except the preparation of men for hospital interneships. I do not think that any student was ever referred to an original article in the literature. Our diet was one hundred per cent. text-book. When I was interning at the Presbyterian Hospital, however, my chief, Dr. Francis Kinnicutt, for the first time in my career brought me face to face with an original article, and it was one of Dr. Edsall's papers dealing with typhoid fever. That started me on a study of typhoid that lasted for many years. Since that time I have frequently been indebted to Dr. Edsall's contributions and it was only a week ago that I had to consult and quote one of his articles on respiration.

Dr. Edsall was a leading member of the group of research clinicians who changed the whole atmosphere of clinical medicine in this country. His own studies were important, but I think the medical world is even more indebted to him for his share in the development of the Harvard Medical School. It is not too much to say that during the period of his deanship Harvard has taken the leading position among the medical schools in this country. The situation in Boston has been particularly fortunate, although I suppose there have been difficulties that are not apparent to New Yorkers. Harvard seems to have worked out a happy

solution of the perplexing problem of full time versus part time, combining the advantages of both systems. The research work coming from the group of institutions that constitute the Harvard Medical School has been outstanding, as evidenced by the meetings that are held in Atlantic City in May. The program always has a prevailing Boston accent.

A medical school must be judged not only by its research but also by its students. For many years I have worked with Harvard graduates as internes and residents and they have been splendidly trained. In selecting internes I have been interested in comparing the attitudes of the fourth-year students from different schools when they apply for positions. There is one excellent school whose graduates convey to you their conviction that you would be particularly fortunate if you secured their valuable services. Our own fourth-year Cornell students usually go to the other extreme. The Harvard students make you realize that they know their superior value but that they have been very thoroughly trained in concealing this fact. Please forgive the Irish bull, but it is the only way in which this point can be expressed. Perhaps it is unnecessary to say anything more about Harvard University, since it has now received eleven stars in the *Atlantic Monthly*.

The problems of medical education are as old as the hills. The first reference that I have found to a medical faculty is in the twelfth chapter of Psalms. The prayer book gives this translation of the fourth verse: "We are they that ought to speak, who is lord over us?" This surely must be a chorus from the faculty when King David was considering a change in the budget or the appointment of a new dean. The next verse was evidently contributed by the social service department, as it speaks of "the comfortless troubles' sake of the needy: and because of the deep sighing of the poor."

Throughout the course of history and until the seventeenth or eighteenth century the development of science and the practice of medicine were combined and practitioners were leaders in contributing to university work. In the last century they have fallen behind. The actual definition of university work is difficult. Certainly it is not confined to the university, since university ideals sometimes reach their highest development in commercial laboratories and research institutions. Perhaps the true university spirit is most concentrated in a place like Woods Hole, which is not controlled by any one university but represents a spontaneous and informal gathering of teachers and students.

The medical colleges have put too much emphasis on the division between the so-called pre-clinical and clinical subjects with the assumption, evidenced in this very program, that the pre-clinical departments are more closely related to the other graduate schools of the university. This is, perhaps, the natural result of the fact that such departments as anatomy and physiology have no clinical responsibilities and their duties are much the same as those in the non-medical parts of the university. Similarity of ideals is most desirable and effort should be made to bring the clinical departments more fully into this highly esteemed atmosphere. The chief difficulty lies in the fact that the clinical departments have a double duty. They must give the best possible medical care to their patients and administer efficiently large clinics with limited budgets. The care of patients is always the major responsibility and nothing could be more disastrous in the education of medical students than neglected patients.

In discussing the clinical departments it is necessary to consider not only medicine and pediatrics where research has been well supported in the past but also psychiatry, obstetrics, surgery and the many specialities which have received comparatively little attention. It is dangerous to make sweeping statements, as conditions vary in the different schools and different departments. Some of the so-called minor specialities in some of the schools have been highly developed in their research work. Surgery is taking a leading place, as, for example, at Harvard, where its contributions to physiology have been more important than those of most departments of physiology. In general the volume of research publications from the clinical departments has been large, the quality uneven, but some of it well up to the standards of the pre-clinical departments. This is evident in going over the bibliography of a man like Dr. Edsall and the clinicians of the Harvard Medical School in the period of Dr. Edsall's deanship. In order to evaluate this it is necessary to consider the prevalent opinion that work on animals is more scientific than work on man. Probably this false idea rose from the large mass of clinical reports made in past generations by clinicians with little or no scientific training. Perhaps this applies also to the great majority of clinical reports at the present time. Clinicians must live down the somewhat shady past. Nevertheless, the clinical departments of this and other countries at the present time contain a great many men who have been trained in quantitative work, whose technique is fully adequate, whose care in handling controls is up to the best standards and whose knowledge of statistical methods is duly mixed with common sense. There is not time to list the important contributions that have been made, neither is it necessary in this gathering. The clinic affords opportunities which in many respects are much better than can be found in laboratories dependent upon animals.

Nature has performed upon patients experiments that are as yet beyond the technique of the physiologist. It is the careful study of such morbid processes that give the scientific clinician his chance to advance knowledge. If his methods are as good as those of the physiologist who works with animals, the significance of his findings will be greater, since more is known about the normal standards for humans, more controls are available, more cooperation possible.

In reviews of physiology, biochemistry and immunology, a large share of the references deal with the work of clinicians. It might be said that in preparing these articles the clinicians have temporarily made themselves physiologists, biochemists or immunologists. That is because we are in the habit of putting research into certain pigeon-holes that correspond with university departments. Let us suppose that a new pigeon-hole were made and a department of pathological-physiology established in every medical school. The only way in which adequate staffs could be obtained would be to draw men almost entirely from the clinical departments. In this particular field the clinics have certainly contributed to university work. It is not the main purpose of my talk this afternoon to point out accomplishments of the past but rather to call attention to some of the defects of the present and possible methods of improvement.

Although the contributions from the clinics have been considerable the conditions are far from satisfactory and there are many departments in good medical schools that have lagged far behind, and many specialities where drastic reorganization and a complete change of spirit are necessary. The present state of affairs is partly the result of historical development. The non-medical departments of the university were built up around scholars who attracted students, and the technical training of these students was secondary to scholarship. The medical schools were built up around hospitals and individual practitioners, and their chief aim was an adequate technical training that would prepare the students for the practice of a profession. Their aims were not so very different from those of technical high schools that turn out stenographers and skilled mechanics. Upon these medical institutions in recent years was engrafted an idea of pure scholarship, research for its own sake, and a love of investigation which might or might not have practical results but would add to the sum total of human knowledge. These are the aspects of the clinical subjects that constitute "university work" as opposed to what might be called "technical school work." It was realized that if a teacher thoroughly loved his subject he would be willing to spend, in fact, he could not help spending, his time and energies in an effort to increase knowledge in that subject. Formerly the head of a clinical department was selected entirely on account of his ability as a clinician, teacher and administrator. Recently, more and more emphasis has been placed upon research, and now in many of our best schools, one of the chief, perhaps the chief qualification, is the evidence of originality in research. The man selected on this basis finds that all the older requirements must be fulfilled also. The larger part of his time is given over to the organization of the clinic, the care of patients and teaching. He has to supervise the work of a hundred or more doctors and provide for the adequate care of a large number of bed patients, as well as a huge clientele in the out-patient department. He must manage the difficult task of running his part of the hospital efficiently and economically. He must always be available for conferences with his assistants and with students. Such time as remains from these administrative tasks can be given over to the teaching and research, but he must be prepared to leave them at a moment's notice for any one of the hundred claims that are made upon a clinician who is responsible for patients. It is difficult, if not impossible, for him to continue to devote himself to a major research problem of a fundamental nature and there is usually a falling off in the quality of his work. The department depends more upon the younger men who have larger shares of free time, although in periods of stress these may be seriously limited.

The organization of the modern clinic is a combination of hospital and medical school, usually with budgets contributed from two different sources. Allowances are made for pure investigative work, but they are the most vulnerable parts of the budget and, of necessity, are greatly restricted in times of depression. Fortunately there are usually supplemental funds that have been given by generous donors for special work over limited periods. There are scholarships and research fellowships. In some cases there are affiliated research institutes. In general the departments that stand out as leaders attract more of these funds and more research fellows, but there are some sterile departments that have charge of the expenditure of research funds that are largely wasted. Relatively few of the specialties receive much support.

Clinical research is by no means restricted to the universities, since there are notable institutions, such as the Hospital of the Rockefeller Institute, which have no university connections. Some research funds are attached to hospitals where there is no teaching. Others given by wealthy donors to favored individuals have been quite barren but could, perhaps, be made exceedingly useful if they were in the proper surroundings.

The most important part of any clinic is the group

of younger men engaged in research and teaching. They are attracted to a career in academic medicine and after a long period of training are appointed research fellows or instructors and begin to wonder about the future and chances for advancement. They find themselves near the base of a pyramid which becomes much narrower in the zone of assistant and associate professors and extremely narrow when it comes to heads of departments. Inasmuch as academic advancement depends upon research the young man feels that he must devote himself to several years of research, even though his talents may be directed more toward executive work or teaching or the clinical care of patients. On the other hand, the man who wishes to devote the major part of his time to clinical investigation of a truly scientific nature does not see any possible future unless he remain always an assistant. Attainment of the conventional goal of his ambitions would take away the best opportunities for research.

This sounds over-pessimistic and there are many exceptions. But in general it is not encouraging to look over the list of publications of men after they have become the heads of large clinical departments. I shall never forget the most interesting part of my brief medical education in Germany. The laboratory was a small one and the dozents would gather in one corner and discuss their vital problems, such as whose name should stand first on a paper and how so and so who had just published an excellent new book should marry a rich wife in order that he might pursue his career in science. Once I overheard them talking about a German doctor I knew, who had been doing some splendid research work in fever. One of them said, "He has just been made professor and that means the end of his research." I could not quite understand this, as the professorship did not involve any particular increase in his executive duties or teaching. Apparently the comments indicated that since his goal had been attained he would then be satisfied. It is perfectly true that in this case the man's contributions fell off in importance within a few years. In our country the change in title makes no difference to a man who is interested in investigation. The thing that stops him is the sudden increase of executive responsibility. Recently I have had to look up the bibliographies of a large number of heads of departments and it is evident that if a chart were made of the important contributions of these men, there would be a marked drop in the curve just about the time that each man was appointed head of a clinical department. Is the appointment to a professorship the equivalent of an artificial menopause?

Up to the present time there has been relatively little careful planning for the best methods of exploration in the field of clinical medicine. Without much thought on the matter clinics have been made larger and larger, following in a general way the tendency of naval experts who have increased the size of battleships. The modern medical clinic is not unlike a battleship and the commanding officer is asked to explore in a vessel that is entirely unsuited for the purpose. Only a few explorations in the old days were made in large vessels. The most successful were in small ships capable of going up rivers, ships no larger than was necessary to make them safe for the roughest waters that they would encounter. Small expeditions go far. Polar exploration brings out this point. If one were to review it in medical fashion it would go something like this: "The North Pole was discovered in 1909 by Peary with the technical assistance of Henson and four Eskimos and his findings have since been confirmed by Byrd, and Amundsen, Ellsworth and Nobile, and Wilkins."

What is the best-sized organization for exploration in clinical subjects? It must not be too large or it will lose in mobility, flexibility and ease of management. It must not be too small or it will not be self-supporting and free from the danger of storms. These requirements can not be fulfilled by a large clinical department or by a small scholarship fund. There exists, nevertheless, a type of organization that is well adapted for the purpose of exploration in affiliation with a large clinic; a type that I believe should be much more utilized in this country. I refer to the moderate sized research funds and institutes that are attached to some clinical departments. For many years it has been my happy experience to be associated with one of these institutes, the income from which has amounted to from $12,000 to $16,000 a year. Inasmuch as it has always worked in laboratories that have been provided by hospitals, its overhead expenses have averaged about $400 a year. Its business management has required three or four hours a month. Practically all the funds and the time of the staff can be devoted to research. There are several other funds of this nature and I believe that there should be many more of them. If they were administered by the proper boards of directors they could be moved from one institution to another, depending upon the opportunities that were offered. If a certain clinical department were administered by an able man he might have affiliated with his department two or three such funds, with staffs that could devote most of their energies to research and still have time to participate in teaching and the care of patients.

Perhaps supplements of this nature are not needed in the best clinical departments where work of the highest order is already well established. I am thinking chiefly of several classes that would need such help. There are, for example, the good clinics that have

plenty of room but no funds. There are the clinics of the able administrators who happen to be incapable, themselves, of directing research, yet extremely anxious to foster research in their own departments. Finally, there are the large numbers of clinics in the specialities where the technical school type of training prevails and where the ideals of university work have scarcely penetrated. Unfortunately there are very few of the leading specialists who care to devote themselves to research. Those who have ability are lured into lucrative practice.

I am trying to visualize a department of medicine or surgery or ophthalmology or orthopedics affiliated with one or more research institutes of the nature that I have described. There would be an atmosphere of investigation and all members of the staff would be exposed to a well-trained group trying to advance knowledge in that particular field. The scientific director of the institute and the other members of the group would spend most of their time in research, though participating in the work of the clinic and teaching. Undergraduates and research fellows would be given opportunities for conducting special studies in the proper surroundings, under the supervision of a scientifically trained man with plenty of time for conferences. There would be a sense of permanency and security as long as the work was properly conducted. There would be a realization of the fact that poor work, lowered standards, unnecessary friction, would be answered by a transfer of the institute or a change in personnel. If I am not mistaken a widespread use of such institutes might have an effect in changing the requirements for the heads of clinical departments. Ability in organization, care of patients and teaching would be just as important as ever, but there would be less emphasis on the necessity of finding a man capable of original work. Of course, it is highly desirable that the head of every clinical department should have this qualification, but it is a rare qualification, almost unattainable in some of the specialities. It is hard enough for a university to find such men for some of the major clinical departments. There is great danger that universities, in their desire to meet this particular requirement, may unconsciously practice self-deception and overrate the research work of certain men who are highly desirable for other reasons. The vociferous opposition of some clinicians to research has been stimulated by their contact with men inadequately trained, attempting research chiefly for the purpose of self-advancement. Such objectors soon lose their hostility when they come in contact with the real scientist. What they resent is the attitude that research work is required from every candidate for academic position, whether or not he be fitted for it by nature and training.

I visualize a clinical department with a chief who is anxious to provide the proper facilities for investigation and who is heartily in sympathy with university ideals. If he himself can contribute it is to the great advantage of the department. He would have as associates, in addition to other members of his clinical staff, one or more directors of institutes—men who are making reputations for themselves in research, reputations that depend not on their titles as heads of clinical departments but on the quality of their work. The position as scientific director of an institute of this nature would be the natural goal of a man whose talent lay in research rather than administration.

If a development of the clinics is to be made along these lines it is necessary to consider the view-points of possible donors of funds, of university presidents, of heads of clinics and of the younger men. In normal times there are many public-spirited wealthy men who are anxious to promote research in some particular field. They are naturally apprehensive lest funds may become sterile. Suppose that you were such a donor and I were asking you to provide an endowment of a third or a half a million dollars for some investigation that was badly needed. I would suggest founding an institute with a board of directors carefully selected from leaders in medicine and education. They would be given power to affiliate the institute, for periods of five years or more, with any hospital or department where the work could be performed to the best advantage. Preference, of course, could be given to some one university. On due notice the fund could be transferred to another clinic. The scientific director of the institute would be given an adequate salary and would devote his major interest to the development of knowledge in the field to which he was assigned. The clinic would provide space and facilities, the institute take care of technical assistants and supplies. Unless I am greatly mistaken, you as donors would be satisfied that the best possible use would be made of your money.

If several funds of this nature were available in a university, the president would be able to see that they were given to the proper departments. He would make use of opportunities previously wasted and strengthen deserving clinics that needed help.

The head of a clinic could not but welcome affiliated institutes of this sort. He would realize that he himself and the members of his staff would be able to collaborate in research of a fundamental nature. He would know that if things did not turn out well the agreement could be terminated on proper notice.

Finally, it is necessary to consider the effect on the younger men who are devoting their lives to a career in academic medicine. They would be assured of a

proper training and a full opportunity of showing whether or not they possessed enough originality to conduct independent research. If they proved capable and sincerely desirous of a career in research, they could look forward to a life position as scientific director of such an institute. Those who found that their chief talents lay in the direction of teaching and administration or of private practice would select other careers. The final result in the clinics would be a diminution in the number and improvement in the quality of publications. I have considered the young men last because they are the most important, since the future development of the clinical subjects in university work lies within their hands.

THE RELATION OF MEDICINE TO THE FUNDAMENTAL SCIENCES

By Dr. LAWRENCE J. HENDERSON

ABBOTT AND JAMES LAWRENCE PROFESSOR OF CHEMISTRY, HARVARD UNIVERSITY

THE practice, teaching and science of medicine have never been isolated from the other affairs of men, but have modified them and been modified by them. My subject is this interaction, for I have been commanded to speak of it as it exists now and especially as it exists here at Harvard at the end of Dr. Edsall's administration under the influence of changes that he has directed. These changes are the consequence of forces and tendencies that Dr. Edsall has controlled and utilized. The changes are great, the forces strong, the tendencies by no means superficial. All three are manifestations of important intellectual and social processes which concern the university as a whole as well as its parts, and which involve both private affairs and the state itself.

Familiar facts suggest that in order to fix our ideas we may speak loosely of three periods of the interaction from and toward medicine; the first, a very long one when the influence was directed chiefly from medicine outward; the second, a period of transition strikingly marked by the influence of biology, of chemistry and of physics upon medicine; and a third recent period when actions and reactions between medicine and other human affairs are so numerous, so prompt and so intricate that we can hardly follow the chains of cause and effect. These periods are by no means distinct, but it is clear that we are living in the third.

In the beginning and until recent times the action was, as I have said, outgoing; but it took many forms, so many that we can no more than sample the facts. Under the influence of his early medical environment Aristotle turned from the philosophy of his master, Plato. Here at the outset is one action that has never ceased. Like Aristotle, Darwin was the son and grandson of physicians and it is thought that he, too, received the tradition. Also, he, like his cousin Francis Galton, or, to go to another extreme, like the critic Sainte Beuve, pursued medical studies, and in all three the influence of these studies has been noted. Again and again medicine, like the church, has provided a livelihood and so made possible an intellectual life, as it did for Rabelais, for Cardan the mathematician and for Helmholtz.

In an earlier day the path to other fields often led through the study and practice of medicine. Gilbert investigated the magnet, Redi the generation of insects, Stensen geological stratification. John Locke passed from medicine to a psychological epistemology; Sir William Petty, one of the most intelligent of seventeenth century Englishmen, to statistics and economics; Quesnay, the best of the physiocrats, to economic theory guided by an idea of economic circulation borrowed from physiology. In the seventeenth century physicians contributed more than their share to a movement of the first importance in the evolution of science—the founding of academies.

The needs of medicine have created new sciences. They directed the attention of Vesalius to the systematic renewal of the science of human anatomy, of Harvey to his researches on the circulation of the blood and, still farther afield, to embryology. They led to the foundation in Paris of the garden for medicinal plants that finally developed into the Muséum—for one long period the greatest center of natural history in the world. They led Joseph Black, a professor of medicine and chemistry at Edinburgh, to his memorable work on carbon dioxide and on calorimetry. Medicine has also provided the stimulus to new developments. For instance, it was an accidental clinical observation that suggested to Julius Robert Meyer the principle of the conservation of energy.

Medicine has formed the background of the life and thought of humanists like Linacre and of physicists like Young. In other instances, for example, in the political careers of Marat and Clemenceau, we remain in doubt and can but guess about the nature of the influence. Finally, we may note the familiar and characteristic type of the physician-man of letters. At Harvard this brings to mind the elder Oliver Wendell Holmes in the past and, in the present, Harvey Cushing and Hans Zinsser.

Gradually the influence of the more abstract sciences