SCIENCE

VOL. LXI APRIL 3, 1925 No. 1579

CONTENTS

Thoughts on the Teaching and Practice of Medicine: PROFESSOR W. S. THAYER 349

A System of "Definitive Units" proposed for Universal Use: DR. GEORGE A. CAMPBELL 353

The American Association for the Advancement of Science:

Associated Organizations: DR. BURTON LIVINGSTON 357

Scientific Events:

Expedition of the California Academy of Sciences to the Revillagigedo Islands; Fellowships in Cooperation with the Bureau of Mines; The Research Club of the University of Michigan; The American Chemical Society 359

Scientific Notes and News 361

University and Educational Notes 365

Discussion and Correspondence:

Method of Measuring Deep Sea Tides: PROFESSOR R. W. WOOD. *Observations of Shadow Bands:* PROFESSOR S. A. MITCHELL. *The Segregation of Physical Geography:* DR. F. A. CARLSON. *Microsporidia:* ROKSABRO KUDO. *Is Our Plan of Meetings the best possible?:* M. C. MERRILL 365

Evolution in Education in California 367

Scientific Apparatus and Laboratory Methods:

A Simple Membrane Manometer: PROFESSOR ARTHUR D. HIRSCHFELDER AND RAYMOND L. GREGORY 368

Special Articles:

Tree Trunks, Growth and Reversible Variations in Circumference: DR. D. T. MACDOUGAL. *The Purification of Zirconium:* DOROTHY HALL BROPHY 370

Science News x

SCIENCE: A Weekly Journal devoted to the Advancement of Science, edited by J. McKeen Cattell and published every Friday by

THE SCIENCE PRESS

Lancaster, Pa. Garrison, N. Y.

New York City: Grand Central Terminal.

Annual Subscription, $6.00. Single Copies, 15 Cts.

SCIENCE is the official organ of the American Association for the Advancement of Science. Information regarding membership in the association may be secured from the office of the permanent secretary, in the Smithsonian Institution Building, Washington, D. C.

Entered as second-class matter July 18, 1923, at the Post Office at Lancaster, Pa., under the Act of March 3, 1879.

THOUGHTS ON THE TEACHING AND PRACTICE OF MEDICINE[1]

TWENTY years ago at St. Louis I pointed out the contrast between the definitions of medicine in two French dictionaries published one hundred years apart.

In a dictionary of the academy published in 1789, one may read these words: "Medicine . . . the art that teaches the method of preserving the health and healing diseases . . . (Medicine is a conjectural art)."

And one hundred years later in Littré's dictionary: "Medicine . . . the art which aims at preserving the health and healing diseases, which is based on the science of diseases or pathology."

The first definition was not quite fair, for already, in 1789, there had been for centuries those who had carefully observed and recorded and reasoned, and laid unshaken foundations for the scientific basis on which the medical art has come to rest. But the dramatic contrast between the medicine of the French revolution and the medicine of one hundred years later was hardly exaggerated.

Fifty-one years ago, in but a few weeks, the association between two great men began with this letter to Louis Pasteur:[2]

My dear Sir:

Will you allow me to offer you a pamphlet which I am sending you by the same post, which gives an account of some studies on a subject on which you have shed so much light, the theory of germs and fermentation? I like to think that you may read with some interest that which I have written on an organism that you first studied in your memoir on so-called lactic fermentation.

I know not whether the British Annals of Surgery have ever come under your observation. If you happen to have read them you have probably found, from time to time, notes on the antiseptic system which I have been putting to the test during these last nine years.

Let me take this occasion to offer you my most cordial thanks for having demonstrated by your brilliant researches the truth of the theory of the germs of putrefaction, and of having thus given me the only principle which could bring an antiseptic system to a satisfactory completion.

If you should ever come to Edinburgh it will, I fancy,

[1] Remarks made on the occasion of the dedication of the Colorado State Hospital and School of Medicine on January 23, 1925.

[2] This is translated from Valléry-Radot's "Life of Pasteur." I know not whether the original was in French or English.—W. S. T.

be a real pleasure for you to see at our hospital in what large measure the human race has profited by your work. Need I add what great satisfaction I should feel in showing you here that which surgery owes to you?

Excuse the informality which springs from our common love of science, and believe in the deep regards of

your sincere

JOSEPH LISTER

This was scarcely fifty years ago. Pasteur was striving, with but mediocre success, to impress on his surgical friends the necessity of antiseptic precautions. Think again of the progress of the art of medicine in its broadest sense and of its scientific foundations in these fifty years!

'Twas but yesterday—forty years ago—that I entered the school of medicine. It is interesting to recall the difference between the study of medicine in 1885 and to-day.

Forty years ago there were, connected with the few best medical schools in the country, good laboratories for the study of two of the fundamental medical sciences—anatomy and physiology. Pathological anatomy, although in Europe studied as a science, was, in most American schools, still taught by practitioners. The science of bacteriology was in its infancy.

In the medical wards of the hospital, instruments of precision were limited mainly to the thermometer and the stethoscope. The ophthalmoscope, the laryngoscope, the otoscope, were rarely used other than by the specialist. Endoscopy in all its forms was practically unknown.

The laboratory for the entire medical and surgical service when I began my hospital interneship, consisted of a room about fifteen feet long by six feet wide, including the hood, with one window. It was used for simple clinical examinations of the urine and an occasional blood count.

He who began the study of medicine too often entered the school with no knowledge whatever of chemistry; and the instruction was restricted to a few months' course in qualitative analysis, a few months' training in the examination of the urine and a few lectures on the theory of organic chemistry. It was only in the laboratories of the departments of physiology, anatomy and pathological anatomy that the student might have been lured toward a purely scientific career.

Consider the growth of the scientific foundations of medicine since that day—the growth of our knowledge of bacteriology and the relation of infection to the diseases of man and animals, of serology—the increase in our knowledge of physics and chemistry and their application to all manner of anatomical and physiological problems, normal and pathological, to pharmacology, to bacteriology, to serology, to diagnosis—the aid brought to the medical art through the introduction of such physical methods of investigation and of treatment as have sprung from the applications of galvanometry and roentgenology.

Those winged forty years have seen the entry into medicine of many methods of precision, accurate quantitative chemical and physical procedures, and alongside of the laboratories of pure science in the university, laboratories of applied science have found their way into hospital clinic and, indeed, into the doctor's consulting room.

All this has greatly strengthened the arm of the physician. It has taught him the cause and methods of prevention and sometimes of arrest of many of the gravest scourges of mankind; it has explained the nature and pointed to the means of prevention of previously baffling manifestations of disease; it is revealing daily new problems which must be solved. It has greatly strengthened the arm of the doctor, but it has placed upon him heavier and heavier responsibilities.

It is far beyond the power of one human being to master the whole domain of medicine. In the university, in the hospital, in practice, individuals *must* of necessity limit their activities more and more to special provinces of the science or the art. And more and more is division of responsibility and cooperation necessary in medicine as in other spheres of life.

Along with the advances in our knowledge of the natural sciences there have appeared in the world of industry those amazing mechanical devices which have resulted in an increasing delegation of responsibility and division of labor. By the use of complicated machines and by the cooperation of a relatively small number of individuals, each devoting himself to one little division of the work, the finished automobile is constructed in an incredibly short period of time and at a remarkably small expense. That automobile answers its purpose; it has been a boon to mankind. So it is in all branches of industry. The world is flooded with machine-made products which answer their purposes. Labor-saving machines have, in a sense, transformed the industries. Where, in the past, at a considerable expense, an article made by careful individual workmanship, an article that lasted a lifetime, could be obtained by the few, now the many may, at a minimal cost, obtain a like product made by machinery, inferior, to be sure, and lasting but a year or two, but answering its purpose—a blessing in its way to the world at large, but not an unmixed blessing. For society is becoming standardized in its use of inferior products; so accustomed to them and so well satisfied with them that the distinctions between the real and the shoddy are barely appreciated by the many.

Modern industry in great part strives to produce in mass that which will answer its purpose; that which "will do." Scientific progress in the industries has brought labor-saving devices, division of labor and mass production; but the skilled mechanic and his lasting creations are vanishing.

In medicine it is different. The increase of knowledge has of necessity brought with it specialism. In the thorough investigation of a given case, the conscientious physician must often consult colleagues specially competent in special branches. The multiplication of instruments of precision and of accurate quantitative methods in medicine have increased the doctor's opportunities, but they have also increased his duties and responsibilities.

There is no short cut, there are no labor-saving devices in medicine.

It can not be denied, however, that there prevails to a certain extent in and out of the medical profession an odd *mis*conception that the laboratory has supplied us with something absolute which does away with the necessity for careful clinical study.

The patient treasures as a talisman huge sheets setting forth in figures the results of examinations which are beyond his powers of comprehension—figures which, alas, evoke sometimes disastrous mental conceptions. The doctor, as in one instance which I remember, is quite satisfied that his patient has typhoid fever because of a report from the City Health Department that the Widal reaction is positive, despite the evidences of a bacterial endocarditis which stare him in the face.

What a familiar phenomenon it is! And how grave sometimes!

There is nothing absolute in medicine. The human element enters into it at every turn.

We doctors are human beings.

Our patients are human beings.

Our instruments are devised and made and used by human beings.

The results of our tests are read and interpreted by human beings.

Fallibility is human!

The doctor himself must watch and weigh every incident in the course of the disease. He must know when he needs assistance and from whom to seek it.

Figures and words—How we human beings love them!

Figures and words suggest the absolute. The "diagnostic clinic," for instance—wonderful words!

Of what value to the thoughtful physician are volumes of special and laboratory reports if he knows not who made them and the conditions under which they were made?

The growth of those absurdly miscalled "diagnostic clinics" with too widely delegated responsibility is a sad evidence of our thoughtless subjection to the greatest of human tyrannies—the tyranny of words. The difference between the diagnostic opinion of one wise man who may be counted upon not only to give of his own knowledge and experience but to seek that of others when it is needed—the difference between the diagnostic opinion of one wise man and the sheets setting forth a so-called "survey" from the average "diagnostic clinic" or the advertising institute is the difference between light and darkness.

A machine-made diagnosis is a shoddy product; it does not wear well and it rips on the first strain. More than this, it is dangerous; it will not do.

Where forty years ago the questioning, the examination, the observation, the study that enabled a conscientious physician to give his patient his best advice was often a relatively simple matter, to-day it may be a long and laborious problem, time-taking and expensive.

The multiplication of scientific methods of investigation has not transformed; it has broadened the art of medicine. In so doing, it has not diminished; it has increased the duties and the responsibilities of the practitioner, who, to-day, must have a much better general and special education than forty years ago.

To-day the practitioner must, as ever, have a sufficient knowledge of the strictly fundamental medical sciences—biology, anatomy, physiology, bacteriology, serology, pharmacology. But to understand these and appreciate the significance of, if not actually to carry out himself, a large number of diagnostic and therapeutic procedures, he must have no inconsiderable knowledge of mathematics, of modern physics and chemistry, inorganic, organic, physical.

And that which should never be forgotten, but sometimes is forgotten—*this larger scientific basis saves not one hour of the necessary training and experience in the art of physical diagnosis and in the study of disease at the bedside, of that sympathetic contact with suffering men and women through which alone efficiency in the art of medicine can be attained.*

Not all the chemistry and physics in the world can make a good diagnostician or a good practitioner or a good teacher of him who is not at home by the bedside.

One of the greatest defects in the teaching of medicine in America to-day is the lack of sufficient training in habits of accurate clinical observation and description and in the art of physical diagnosis. It is often exemplified by the surprise of the student at the evidences of the acuteness of the observation of the better students of a hundred years ago. Sometimes I wonder if our carelessness in this most vital part of

the training of the doctor is not perhaps a part of a general tendency of the times, a tendency to delegate responsibility, to accept anything that "will do," material, intellectual or moral; to be satisfied with quantity rather than quality; too great a readiness to accept, thoughtlessly, the easier way, as for instance, is exemplified by the rather simple performances of some who practice the so-called "simplified spelling." It is, by the way, hardly conceivable that that man could be capable of discriminating clinical observation who would substitute "thru" for "through."

But to return to our main theme. As the duties and responsibilities and opportunities of the physician and the surgeon have increased, so, also, has the scope of the university school of medicine and the university hospital broadened.

The hospital is the heart of the school of medicine. The first and fundamental function of any hospital is the care of the sick. For this the university hospital should be peculiarly well prepared.

The care of the sick should be carried out best by men who have the best fundamental knowledge of the medical sciences, combined with experience in the art of practice—who have at their disposal adequate means for the thorough observation, study, investigation and treatment of their patients. "Adequate means" signifies to-day a rather elaborate equipment in the way of instruments of precision and of laboratories in which the examinations and studies necessary for the routine conduct of the clinic may be made, and in which special investigations may be carried out under special circumstances. These laboratories will and should vary in various clinics. The simplest form is the single clinical laboratory with a suitable personnel capable of carrying out those routine examinations of excreta, secreta and body fluids which may not be done in the wards. In many university clinics there will arise in connection with the medical service special chemical, bacteriological and serological laboratories which are really laboratories of applied science. These will be presided over by men who, while yet taking part in the clinical activities of the department, are especially interested and qualified students of one special branch of medicine, chemical, biological, physical, as the case may be. Such students and teachers demand adequate salaries, for in their positions they will and do devote many years of their lives to scientific studies in ward and laboratory, to the great advantage of the hospital and the school.

The laboratories associated with one good medical clinic will doubtless differ somewhat in number and character from those of another. It is well that this should be so. According to the special competence of individuals, and subject to special conditions which may exist in a given clinic, special laboratories and divisions of the medical service may rise for the temporary or continued study of special problems—tuberculosis, syphilis, cardiac disease, for instance.

Then the professor of medicine must have an adequate number of junior assistants to help in the study and observation and care of his patients, in recording their progress and especially in making routine minor laboratory examinations. Outside of the regular hospital interne, this desideratum is very difficult to fill fully in other than a university hospital. Here, however, it is filled as nowhere else, by advanced students. These men supply a body of unequalled junior assistants, such as can be obtained in no other way. The employment of the advanced student as a ward assistant, a clinical clerk, as they say in England, has brought the greatest single improvement in our ability properly to care for the sick that has been introduced in this country in my lifetime. I have known wards with and without student assistants; I have known wards in term and out of term time; and I know full well how much better are the chances for recovery of the patients in a ward with student assistants than in a ward attended by the interne alone. When I am ill let me be cared for where there are student assistants!

The second function of the university hospital which is really coordinate with the first—the care of the sick—is the teaching of medicine. The requisites for the two functions are essentially the same. The best teacher is almost always the wisest physician. The wisest physician is always a student. And in order to obtain his services as a teacher, the university must offer him opportunities to continue his studies as well as opportunities for the observation and care of the sick. This means a suitable equipment in the way of instruments of precision, laboratories and associates to preside over these laboratories, with adequate salaries to support the group of senior associates and assistants who will preside over special divisions of the service and special laboratories of applied science and for many years may give their time largely or entirely to hospital practice and teaching and research.

Of primary importance is it that the professor of medicine should have under his control clinical material sufficient to allow him to utilize his full staff. The professor himself can do but a small part of the necessary teaching. The same will be true of the senior associates in charge of the special divisions of his service. The professor must be afforded opportunities to associate with his clinic the necessary group of clinicians. His department must be a clinical center toward which physicians and patients

in the community turn for special advice. Associated with the department of medicine of the university must be clinical professors who are the recognized leaders in their art.

This is vital for the student, for from the example of the experienced clinician he can best acquire proficiency in the art of medicine.

It is vital for the senior associates who must be relieved from unnecessarily arduous clinical duties and should be afforded opportunities to gain themselves that clinical experience and competence which they will ultimately need.

It is vital for the clinic itself, because if the department of medicine of the university be not the recognized clinical center of the community, it will be unable to command the personnel that it should have; it will be unable to do its full duty to patient, to student or to the community; and it will be in grave danger of falling into isolation and mediocrity.

The third great function of the university clinic is that of research. Research means study, analytical and experimental, in ward, in laboratory, in consulting room. A clinic that is properly equipped for the care of its patients and for teaching will be properly equipped for research. The qualified teacher in any branch of medicine is of necessity a student. There is no place in the medical school of to-day for the mere vulgarizer of knowledge. What we try to do to-day is not to feed the student with assertions but to teach him how to teach himself. We seek to teach him methods and encourage him rather to doubt and to prove for himself the truth or error of the assertions of others.

The modern school of medicine and the modern hospital should make it possible for the members of the staff to pursue research, to study their problems more thoroughly by increasing their freedom in every possible way, through adequacy of salary and through affording opportunities in hospitals and laboratories for post-graduate study in the shape of fellowships and voluntary assistantships which enable the chief to contribute to the advances of the medical science and art through the active work of the increasingly large body of young men who are every day seeking the opportunity to give their time to the elucidation of special problems under the advice and direction of a master.

It is, I believe, greatly to the advantage of hospital and university that special opportunities be afforded the head of a department and his chief associates for holding such consultations as they may desire to hold *at the clinic*. This is time saving; it centralizes the work of the teachers at the point of their main activities, and it brings to the clinic an invaluable stream of selected cases of special interest —special problems referred to them by their colleagues from near and far.

Much of such material may not be directly utilizable for teaching purposes before the general student body, but it is invaluable for the staff, especially those members of the staff who are studying special problems.

Every effort should be made to free the chief of a service from unnecessary responsibility or anxiety, for the multiplicity of duties falling on the shoulders of the director of a large department of medicine to-day have come to be a rather heavy load.

The recognition that such men must be adequately salaried is a great step forward.[3] But beyond this the question as to how to deliver the director from the whirlpool of administrative duties is puzzling and serious.

I have said enough. There is no fixed model; no one way by which alone medicine can be or should be taught. I have given you a few of the thoughts which have arisen from my own experience. You have the opportunity, under exceptionally favorable circumstances, of solving the problems in your own way.

The sight of these beautiful buildings, the conversation with those privileged friends who have the chance to show to the world what they can do with the opportunities that lie before them, remind me of the days nearly thirty-five years ago now, when I came to Baltimore, but a year after the opening of the Johns Hopkins Hospital. In those days I was but an insignificant member of the fortunate group of men who had the joy, free and unfettered, of shaping the destinies of that institution.

May you be as free! May your happiness in your work be as great! May your accomplishments be greater!

W. S. THAYER

BALTIMORE

A SYSTEM OF "DEFINITIVE UNITS" PROPOSED FOR UNIVERSAL USE[1]

ABSTRACT: It is proposed that physicists discard the CGS and Heaviside units, which are responsible for much confusion and needless mental effort, and

[3] The effort to put the medical school and medical teaching more and more on an university basis, that is being made in many of our better medical schools, is not a revolution in methods; it is an evolution springing directly from ideals which have always guided the wisest students and teachers and practitioners.

[1] Read at the International Mathematical Congress, at Toronto, August, 1924.