more liberal) knowledge than that provided by the ordinary medical education, whether undergraduate or postgraduate. It presupposes a knowledge of a kind which embraces within it the humanities, the religions, and a deep understanding and sympathy for the living man and a sincere respect for the human personality.

International co-operation in postgraduate medical education, while much greater than it ever was before, is not yet sufficient. And the tragedy of it all is that developments in other fields of science—for example, nuclear energy and conquest of space—are proceeding so fast that we appear to be lagging behind. Not only this; we would have to face the challenge of these developments, and if in the hour of need we fail, we shall not only be held to blame but to ridicule as well.

Do not for one moment think that remote countries, underdeveloped countries, or small countries will not be able to contribute anything significant to the development of postgraduate medical education. Underdeveloped countries and such countries as I live in can contribute much, but the fact of our contributing something to your knowledge, and your even greater contribution to us, would be as nothing compared with the synthesis that will emerge as a result of this co-operative effort. A broader vision, a wider field, and a more deliberate appreciation and consciousness of our purpose and aims will be furthered by such efforts, and I make an appeal here and now that we should intensify international co-operation in postgraduate medical education with the least possible delay.

THE VALUE OF PARTICIPATION IN RESEARCH AS A COMPONENT IN THE EDUCATION OF DOCTORS FOR THE MEDICAL, GRADUATE, AND POSTGRADUATE STUDENT*

BY

VICTOR JOHNSON, M.D., Ph.D., Sc.D.

Director, Mayo Foundation for Medical Education and Research; Professor of Physiology, University of Minnesota Graduate School, Rochester, Minnesota, U.S.A.

There is no need to document the value of medical research as a major factor in the constantly improving well-being of mankind. It could be convincingly contended that our knowledge of health and our control of disease have progressed farther in the last 50 or 60 years than in all the preceding countless ages of man.

Further, it is unnecessary to declare the value of participation in research for a medical student who anticipates either a career of full-time investigation or part-time clinical research supplementing the practice of medicine. The methods and tools of research, the nature and conduct of investigation, must be learned early. A physician who has done no investigation by the time he has finished his postgraduate residency training is unlikely to make significant contributions to research in his subsequent career.

It is self-evident that research must continue to increase our understanding of man in health and disease, and also that experience and training in scientific investigation are essential at an early stage in the education of the physician who intends to continue to carry on research. This presentation is concerned rather with the value of participation in research as part of the experience of a medical student who may not again work in a research laboratory, who has no intention of conducting further clinical investigation, or who will never write another scientific paper. Some training in research can contribute enormously to the education of such a physician, engaged entirely in clinical responsibilities, as is necessarily the case with most physicians.

Evaluation of Research Reports

Past research experience by a physician who is now fully engaged in clinical practice sharpens his judgment and enhances his evaluation of the research of others. "Medicine, a lifelong study," requires the physician to keep abreast by reading the journals and listening to scientific papers. Research necessitates a struggle with

data collected, requires a sifting and sorting of experimental results, insists upon a recognition of deficiencies in the supporting evidence, compels the reaching of conservative conclusions warranted by the objective findings. Experience in research warns against the pitfalls of inadequate numbers of observations, faulty controls, inaccurate measurements, the intrusion of chance, the inherent variability of biological material. Engagement in research enhances the physician's judgment of conclusions reached in medical papers he reads, sensitizes him to inadequacies of evidence, increases his wariness of exaggerated claims, tempers his acceptance of enthusiastic predictions.

Difficulty of Discovery

Research has been called "a way of making Nature talk." But Nature guards her secrets with intense jealousy and is loath to speak. Research reveals the painful difficulty of discovery.

To the layman, who reads only the newspaper or popular magazine accounts of discovery, the pathway is easy. To the more sophisticated, such as a medical student or practising physician, somewhat familiar with research literature, the difficulty of making a contribution to knowledge becomes more apparent. But it is only the student or physician who has actually participated in research himself who is completely aware of the tremendous effort and patient toil which are exacted of an investigator who establishes even a very little new fact or a causal relationship.

A celebrated exception to this axiom was the discovery of vagus material, by Otto Loewi. He recounted that he had an idea one night, in bed, and went to his laboratory next morning to test his thought. In this instance, only a day elapsed between the idea and the demonstration. New principles of broad physiological application emerged: not only the concept of neuro-humoralism but eventually also the theory of chemical transmission of nerve impulses across synapses.

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Much more characteristic of the unhasty pace of research discovery is the story of insulin, with the long and laboured span of three decades between the experimental production of diabetes in dogs and the beginnings of its control in man. Years of frustration were the only rewards of investigators probing this most jealously guarded secret of nature. The dual function of the pancreas, as a digestive and an endocrine gland, the concept of hormonal secretion, the idea of replacement therapy, the enzymatic destruction of islet secretions in crude pancreatic extracts, the correct pH to preserve the islet-tissue hormone, the embryonic history of the pancreas (noted and utilized by Banting), the purification of the embryonic extracts of islet tissue free from digestive secretions, and, finally, the therapeutically successful injection of these extracts into diabetic dogs, took years and years and years of labour and failure and frustration.

The struggle for insulin soundly documents that hard lesson of research experience, the difficulty of discovery.

Pursuit of a Scientific Hobby

Even though a physician may do no research or engage in a limited specialty such as cardiology, a past research experience may provide a rewarding hobby or special interest to be followed at least in the literature and perhaps also at scientific meetings.

The postgraduate resident physician who spends only three to six months in a cardiac catheterization laboratory might be prompted to follow subsequent findings in this field with considerable gratification. He will observe with special appreciation the latest developments in artificial blood circulation, extracorporeal aeration of blood, refrigeration, control of cardiac arrest, electrical pacemakers, intracardiac prostheses, repair of valves and septal defects—the many discoveries to come in the control of congenital and acquired cardiac defects.

Alertness for the Unexpected

Research develops an alertness to the apparently inconsequential. In carrying out any research project it soon becomes apparent that it is essential to be for ever on the alert for an unexpected observation sometimes seeming almost to be an accidental occurrence.

Each such occasion must be given due weight. The incidental observations may prove to be far more important than the original goal sought in the experiment. The magnitude of Fleming's discovery was not at all apparent from his simple description of an experimental accident of vast moment: "While working with staphylococcus variants a number of culture-plates were set aside on the laboratory bench and examined from time to time. In the examinations these plates were necessarily exposed to the air and they became contaminated with various micro-organisms. It was noticed that around a large colony of the contaminating mould the staphylococcus colonies became transparent and were obviously undergoing . . . [destruction]."

This kind of alertness to apparently insignificant detail, not directly in the pathway of the moment's reflection or not immediately integrated into the experimental context, has yielded many a discovery. For lack of this sensitivity how many important discoveries were missed: the vector of transmission of the poliomyelitis virus, the arresting of mitosis in cancer cells, the dissolving of a blood clot in a coronary vessel.

Clinicians who rise above the common lot have, perhaps in many instances through research experience,

similarly become allergic to the minute, the obscure, the incongruent. A few tiny petechiae may point to a sub-acute bacterial endocarditis in an obscure complex of signs and symptoms. A 30-year history of healed pulmonary tuberculosis might provide the diagnostic clue to a painful palpable mass in the pelvis.

Collaboration in Clinical Practice

Research provides lessons in team-work. Little modern research of consequence is carried on by the lone investigator. More commonly in evidence is the combined effort of experts in several disciplines. Studies on poliomyelitis vaccine necessitate collaboration between the bacteriologist, neurologist, internist, statistician, epidemiologist, biochemist, pathologist, and others as well.

Team-work in clinical practice is equally necessary, particularly in dealing with complicated problems. In a modern clinic it is not unusual for experts from half a dozen or more clinical specialties to collaborate in arriving at a diagnosis and determining management.

Who does not learn, perhaps in an experimental laboratory, this lesson of team-work in the practice of medicine and the employment of consultations by a collaborating group will be much less than a good physician.

Persistent Routine

Research fosters a respect for persistent routine. Inspiration and glamour are not prominent in the continuing plodding which is demanded. The researcher patiently repeats the experiment again and again, week upon week, changing the procedure, perfecting the technique, analysing the failures, month after month doggedly pursuing the goal with no assurance of reaching it. There is an abundance of routine and boredom demanding inordinate tenacity to continue the venture. What thousands of dull red-blood-cell counts for long hours of many months provided the evidence to Whipple that liver accelerates red-blood-cell production in anaemic dogs! How many frog nerve-muscle preparations were carefully dissected by Helmholtz before he determined the speed of the nerve impulse!

Everyone who would contribute importantly to the world's work must learn this lesson of persistence in routine. The President of the United States must spend a lot of time writing his name. The concert pianist must practise alone for hours on end. The physician must percuss the heart borders of the hypertensive patient again and again. The medical student must laboriously repeat white-blood-cell counts on the patient with an infection.

The rewards of research or of medical practice demand countless unglorious hours of stubborn work as a routine, as might be found in the performance of many a less pretentious task than medicine.

Highway of Discovery

Research provides knowledge and familiarity with one of the highways of discovery. The study and reading essential in carrying out a research project, determining what has gone before in this area, and what yet needs to be done, are as different from the more casual reading of such material as actually travelling a countryside is different from reading a highway map. The gratification of such an excursion is intensified by the ultimate arrival at the end of the charted road where exploration into the unknown occurs.

The discovery is usually very modest. Often it is a negative finding, the posting of a warning on a dead-end street. Yet it is a discovery, new knowledge, light into the darkness, a penetration beyond the frontier. Discovery, great or small, of what was never known before is an adventure to be cherished, an experience likely to colour a physician's entire outlook on his work. The physician who is imbued with the spirit of investigation, augmented by research experience, will be a little more persistent in his diagnostic searchings, in his therapeutic efforts, or in his self-evaluation.

Summary

Experience in research as a medical or graduate student may stimulate a continuation of some investigation throughout life. Even if the physician does no research after his formal education, his earlier experience in investigation will prove of tremendous value, because research sharpens the physician's judgments of the scientific pronouncements of others, it reveals the painful difficulty of discovery, it stimulates the pursuit of a scientific hobby. Research promotes an awareness of unobtrusive "accidental" phenomena which may be of great importance, it provides lessons in team-work, it fosters a respect for persistent routine.

Research acquaints the investigator and physician with one of the highways of discovery leading into the unknown.

THE VALUE OF PARTICIPATION IN RESEARCH IN THE CONTINUING EDUCATION OF THE PRACTISING DOCTOR*

BY

R. F. FARQUHARSON, M.B., F.R.C.P.

Department of Medicine, University of Toronto, Canada

Education is a continuing process which is dependent upon active studying. Without the critical application of one's mind to the subject, learning proceeds slowly and imperfectly and judgment is apt to be fallacious. The best of all study is when one applies one's energies to the elucidation of problems to which the answer is not known. This is usually called research. It is a broad field in which people with different types of talent may work successfully.

There are many ways in which research may be pursued. In all it is essential to know the background of the field of investigation, and in professional work this demands a sound knowledge of some aspects of one's field of practice and an awareness of the type of problems that may arise in it. It is always concerned with wondering, pondering, dreaming, and speculating about the subject. It always has to do with formulation of problems, sometimes in a broad philosophy, sometimes in a much narrower focus. The persistent endeavour to comprehend the background and the gropings to clarify the problem are all part of the search; and it is the searching that is important in education, not getting the answer. That some person may already have found the answer is not pertinent to the process of learning.

Medical people vary greatly in their essential interest in investigation. In some it is so keen that they are

impelled to spend their lives either in experimental research or in the intensive investigations of disturbances of body and mind in health and disease. These usually stay in university centres, and any practice undertaken is as an associated and minor interest. Others make their living in various fields of practice; it is with them that we are concerned in this discussion.

It is a great mistake, however, to think that the habit of inquiring and the genius for searching are limited to those who devote their lives to organized research work. It is equally wrong to expect the busy practitioner to unearth many new facts or make striking advances. His searching is of a different intensity, spread at first over the broad area of his practice. Should he work in a university centre, and especially if he restricts his practice to a special field, it is easier for him to focus his attention on a specific problem, and often to work in association with laboratory colleagues. In more general practice the field is broader, but many have a largeness of mind capable of embracing a wide field in an intelligent survey. They must at first look at a whole landscape, but the scrutiny may lead to observations that demand focal study, sometimes with the help of others.

Research on Practical Problems

The practising doctor has many opportunities to engage in useful research work, but his accomplishments are likely to be restricted by lack of time to think about his problems and formulate them clearly. The more general his practice the greater is this difficulty. It is of first importance, therefore, that he study in a field that he knows, and that his projects be concerned with some aspect of his regular work. Just as teaching and research should not be separated, so practice and study should go hand in hand. Active studying stimulates the teacher, clarifies his ideas, and helps him gain a clearer vision of fundamental principles, making him a better teacher; in a similar way it stimulates the practitioner, sharpens his powers of observation, and throws light on his daily problems, making him a better doctor. Good habits of thinking, observing, planning, discriminating, and judging well are engendered and nurtured by persistent searchings; and these habits of investigation come to be used in all that one does. Their development requires constant application; hence they must arise and grow from daily use, the research becoming a concentrated effort in problems met with in his ordinary work.

A research hobby outside one's regular work is seldom helpful in education. To devote all his spare time to an extrinsic subject, such, for instance, as the study of tissue culture, actually tends to reduce a practitioner's interest in his patients and their disorders. If he has great talent for more fundamental research, however, it may lead him from practice into full-time research work in the field of his interest and aptitude. Banting taught physiology as a side interest when he began to do general practice after the first world war; the idea of a search for insulin soon took possession of him and changed his life's work.

The Continued Study of Patients

The pursuit of research in practice is not and should not be a separate component of a doctor's life. It is not like a coat that he puts on in moments of freedom

*An address given to the Second World Conference on Medical Education, Chicago, 1959.