Family Medicine as a Science

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The remarkable progress made by academic family medicine in the past ten years has been made in spite of its limited scientific basis. As a body of knowledge, family medicine still has many of the marks of an immature discipline. Whether or not it grows to maturity in the next decade or two will depend very much on the wisdom with which we choose the direction of our research. It will be very important that we avoid the false trails which we could so easily take. Our research must be based on sound principles and a clear understanding of the nature of family medicine as a body of scientific knowledge.

In this paper I will suggest some guiding principles for the future development of family medicine research. I will begin by trying to answer some very basic questions which are important to my argument: what is a science? what is a technology? in what sense is clinical medicine a science and a branch of technology? I will then go on to develop the theme of family medicine as an immature discipline, using as my frame of reference the concept of mature and immature fields of science developed by Jerome Ravetz[1] in his book *Scientific Knowledge and Its Social Problems*. Finally, I will describe the course which I believe we should follow to bring our discipline to maturity.

It is important to emphasize that, in discussing the science of family medicine, we exclude a large and important part of our discipline. Family medicine is not only a science but an art. Although scientific research can make a contribution to the development of an art, knowledge of the art is not gained in this way. My purpose here, however, is to consider only those aspects of family medicine which come within the range of the scientific method.

What is a Science?

One of the commonest fallacies about science—and one to which we have been prone in family medicine—is that by collecting information we are engaging in scientific research. It is true, of course, that the making of precise and reproducible observations on natural phenoma is an essential component of the scientific method. It is in its attitude to accurate observation—what

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Whitehead[2] called "brute fact"—that scientific thought differs from medieval thought. Medieval thinkers were intensely rational, but their arguments were based on *a priori* assumptions rather than the verified facts of experience. A devotion to facts, however, is not in itself sufficient to define the scientific method.

The other essential activity of science is the formulation of explanatory theories which can be tested against experience. It is theory which organizes and gives meaning to our data, helps us to formulate problems, and provides the basis for the interpretation of empirical findings. As a science matures, its body of factual information becomes embedded in an explanatory theory of increasing power and significance. "The factual burden of a science," wrote P. B. Medawar,[3] "varies inversely with its degree of maturity. As a science advances, particular facts are comprehended within, and therefore in a sense annihilated by, general statements of steadily increasing explanatory power and compass . . . . In all sciences we are being progressively relieved of the burden of singular instances, the tyranny of the particular. We need no longer record the fall of every apple." Progress is made in science when a new and more powerful theory is born. The theory may be formulated to explain new facts, but not necessarily so. A new theory may be a new way of ordering facts which are already well known.

These two activities then—observation and theory building—are the essentials of the scientific method. They are also connected with each other in a way which is not always understood.

Although the scientist is devoted to "brute fact," the objects of science are not the raw data of our senses. One cannot observe without having some theory about the objects to be observed. The theory may not be an original one; it may not even be consciously held; it will nevertheless be a world view, derived from our culture and formal education, about how phenomena are to be classified and valued. "Observation is always selective," wrote Popper.[4] "It needs a chosen object, a defined task, an interest, a point of view, a problem. And its description presupposes a descriptive language, with property words: it presupposes similarity and classification, which in turn presupposes interests, points of view, and problems."

The objects of science, then, are intellectual constructs. In medicine, the "diseases" which we describe have no real existence: they are abstractions which we invent to bring order to a mass of data about illness. Abstraction is an essential part of the scientific method, but its danger is that we can so easily become the prisoners of our abstractions.

"The disadvantage of exclusive attention to a group of abstractions," wrote Whitehead,[2] "however well founded, is that, by the nature of the case, you have abstracted from the remainder of things. Insofar as the excluded things are important in your experience, your modes of thought are not fitted to deal with them. You cannot think without abstractions: accordingly, it is of the utmost importance to be vigilant in critically revising your modes of abstraction . . . . A civilization which cannot burst through its current abstractions is doomed to sterility after a very limited period of progress."

It is the "bursting through" of conventional abstractions to which Kuhn[5] ascribes the progress of science in his theory of paradigm change. Progress in science takes place, he argues, when an individual breaks out of the conventional abstractions and, as in a change of visual gestalt, sees the world in a different way. The fact that adherents of the conventional system of abstractions are often incapable of making this change of world view is the basis of many scientific controversies.

Before leaving the subject of the scientific method, one further point should be made about scientific theories. The sciences are not the only branches of knowledge which develop theories. In order to identify a scientific discipline, therefore, we need some criterion to discriminate between scientific and nonscientific theories. Popper has provided this in his criterion of demarcation.[4] A theory is scientific, says Popper, if it is capable of refutation. A theory can never be proved true, no matter how much supporting evidence is collected, for there will always exist the possibility of encountering falsifying evidence. To refute a hypothesis, however, we need only one falsifying instance.

As an example of a nonscientific theory Popper gives psychoanalysis, which, he maintains is impossible to refute because it is capable of explaining any observation, however conflicting. To say that a theory is not scientific, however, is not—or should not be—a pejorative statement. Theories often have great value in helping us to understand experience, even if they are not refutable. It is only that they should not be classified as scientific.

Medicine as a Science

Given this definition of science, can medicine be regarded as a scientific discipline in its own right? We have become accustomed in medicine to distinguishing between basic science and clinical medicine. These terms are not often defined but I often suspect that the term "basic" is used to imply that chemistry, physics, physiology, anatomy, and pharmacology are more scientific and fundamental than clinical medicine. This is really the opposite of the truth, for it would be impossible to apply advances in basic science without a body of scientific knowledge which is only obtainable from clinical observation. In the study of human illness, the ultimate test of any chemical or physical analysis must be: what are its implications for the survival and functioning of the whole organism? And this is a question which can only be answered by clinical observation. This is not only true of medicine, but of all studies of organisms and mechanisms. "Physics and chemistry can establish the conditions for their successful operation and account for possible failures," wrote Polanyi,[6] "but a complete specification of a machine in physico-chemical terms would dissolve altogether our knowledge of the machine . . . . It is as meaningless to represent life in terms of physics and chemistry as it would be to interpret a grandfather clock or a Shakespeare sonnet in terms of physics and chemistry."

Clinical observation, then, is not only a scientific discipline, but is *the* science of medicine. It deals with precise, reproducible observations and it has its own body of theory. Our system for classifying illness is in itself a theoretical construct, and we also have theories of causation, decision making, and proof. Clinical medicine, like astronomy, ethology, anthropology, and a large part of biology, is an observational science. It is one of those sciences which, in Ryle's[7] words, tries to "establish the truth of things by observing and recording, by classification and analysis."

We must go on to acknowledge, however, that clinical observation has been a much neglected science in our own time. In his book, "Clinical Judgment," Feinstein[8] has commented: "Medical taxonomy has given him (the clinician) classifications for the host and for the disease, but not for the illness of the patient who is the diseased host. Lacking any formal means of classifying clinical observations, the clinician has no place to put the information when he communicates with himself or with his colleagues."

Medicine as Technology

Although medicine can be described as an observational science, most of medical knowledge would be more correctly classified as technological rather than scientific. As I hope to show later, the question is not entirely academic. It is true that science and technology have in modern times become so interwoven that it is difficult to tell them apart. It was not always so. Until the mid 19th century, science and technology pursued separate courses. Science was concerned with increasing our knowledge and understanding, largely for their own sakes. Technology progressed by the inventions of practical men, often based on craft skills of great antiquity. The analysis and specification of craft skills was, indeed, one of the chief ways in which technology developed. It is an indication of the gap which existed between science and technology that the industrial revolution was accomplished with hardly any help from science. "Except for the Morse telegraph," wrote Polanyi,[6] "the great London Exhibition of 1851 contained no important industrial devices or products based on the scientific progress of the previous fifty years."

Since that time, of course, science and technology have converged to such an extent that much of technology is now based on science, and technology contributes much new knowledge to science. One might be forgiven for thinking that there is no longer any useful distinction between them: scientists use tools, and scientific research itself is a technical and craft skill; technologists make precise observations and develop theories which can make an important contribution to our understanding. Moreover, the methods which technologists use for evaluating their tools are the same as those which scientists use for testing their hypotheses.

There are also, however, some important differences. Most of these need not concern us here but one, in particular, is important. A scientific discovery deepens our understanding of nature; a technological invention, in Polanyi's words, "establishes a new operational principle serving some acknowledged advantage." The test of a scientific discovery is the question, Is it true? The test of a technological invention is the question, Does it work? A scientific discovery can be superseded only by another discovery which brings us nearer to the truth. A technological invention can be superseded by another invention, or by a change in the way a process or its outcome are valued by society.

Where, then, does medicine stand? As I have already maintained, clinical medicine is an observational science, its subject matter being the phenomena of human illness. It is at the same time, however, a branch of technology devoted to the application of knowledge from many sources to the prevention, cure, and relief of illness. As in many modern technologies, progress takes place in different ways. Much technological innovation now comes directly from scientific discoveries, in medicine chiefly from those sciences which we have described as "basic." In medicine, however, as in other technologies, progress in still made by the specification and transmission of craft skills, and there exists, moreover, a significant residue of craft skill which has not been specified.

If we look at medical research in contrast with basic science research we find that much of it is indeed technological, that is, concerned with the development and testing of tools. I use the word "tools" here in its widest sense to include not only our material tools—instruments, drugs, etc—but also our intellectual and organizational tools: decision making processes, psychotherapeutic methods, and systems of providing health care services.

Now let us turn to family medicine. Family medicine is, of course, one branch of clinical medicine. Like clinical medicine it has both scientific and technological components. Its scientific subject matter is the phenomena of illness as they present to family physicians; its technological aspect is the development and evaluation of the conceptual, organizational, and material tools used by family physicians. The justification for its independent existence is that the tools are unique to the discipline, not derived from other branches of medicine, and that the phenomena can only be satisfactorily studied from within, rather than outside, the discipline. As an independent discipline, however, family medicine is of very recent origin, so we should not be surprised to find that it shows evidence of immaturity.

Family Medicine as an Immature Discipline

I have taken the idea of an immature field of inquiry from Ravetz,[1] who describes this as a field lacking in a body of stable factual knowledge. Students entering such a field, says Ravetz, "do not encounter a collection of standardized materials, presented in digestible form, and utterly reliable and incontrovertible in themselves." Instead, they are presented with "intuitive generalities dressed up as empirical laws, and insecure theoretical speculations masquerading as fundamental explanations." Can we say with honesty that this description does not apply to us? Perhaps we are not quite so bad as this. We may not pretend that our intuitive generalizations have the validity of empirical laws; our theory may be more securely based, our methods better tested. But do we have a body of factual knowledge about the phenomena encountered by family physicians? The answer to this must surely be no, unless it be secondhand knowledge which is entirely derived from other branches of medicine.

Workers in an immature field may respond either appropriately or inappropriately. The inappropriate response is to amass huge quantities of data, manipulate it with sophisticated statistical methods, and construct elaborate symbol systems which are then manipulated in formal arguments. These attempts usually fail because the results of research are vitiated by pitfalls which have not been identified in advance. In a mature field, these pitfalls are known and can be avoided. It is true, of course, that any innovative and growing discipline is bound to have signs of immaturity since, when new ground is explored, all the pitfalls cannot be known. A discipline which is soundly based, however, will be able to make forays into unexplored territory armed with well-matured criteria for the evaluation of results.

In exploring these new fields, however, family medicine has shown some signs of immaturity. We have done our share of accumulating masses of data with the idea that this is what science is all about. Although we have a distinguished tradition of clinical observation, much of our clinical research is based on records kept by untrained observers who were unaware that their records were going to be used for research. Mackenzie,[9] one of our most distinguished research workers, wrote: "One implement essential to the success of our enterprise is a trained observer. It is scarcely realized what a difference there is between a doctor who has systematically trained himself to observe and another who has perfunctorily examined his patients without attempting to improve his powers of observation." Nowadays we tend to assume that a training in research is a training in "methodology" rather than a training in observation.

In describing an appropriate response to immaturity, Ravetz has things to say which we would do well to ponder. First, we should not use physics as a model for what a scientific subject should be like. "It is not necessary," says Ravetz, "for a discipline to be fully "positive," in the sense of imitating physics, for it to make a contribution to the advancement of human knowledge." Technological subjects like medicine, agriculture, and engineering will inevitably—because of their subject matter—deal less with grand theories and abstract knowledge than with observation, classification, and description.

An immature discipline can make a useful contribution to knowledge if it concentrates on three things: technique, philosophy, and natural history.

Technique

A practical discipline can make much progress simply by describing, developing, and testing its tools. This is how much of modern technology developed from craft skills. The process is not as easy as it sounds, for many craft skills are extremely complex and defy specific description. Family medicine is no exception to this. General practitioners have developed diagnostic and therapeutic skills which we have only recently begun to recognize and describe. I think we have made as much progress in this aspect of our discipline as in any other. The way ahead can be seen quite clearly: we need to continue the process of describing and testing our techniques, both old and new: techniques of diagnosis, prevention, management, and organization.

In developing methods for the evaluation of our tools we are fortunate in not having to start at the beginning. As a branch of medical science, we have in the discipline of epidemiology a well-developed method of evaluation. This is why, as Spitzer[10] has pointed out, epidemiology is an important basic subject for academic family medicine. Epidemiology provides a set of principles and methods: it is up to each discipline to apply these to its own problems, fully cognizant of the unique pitfalls which exist in every discipline. The research worker in family medicine, therefore, should be well versed both in the general principles of epidemiology, and in their application to his own discipline.

Philosophy

The purpose of philosophy in a scientific or technological discipline is to subject its basic assumptions to critical examination. It is surprising how often, in well-established disciplines, this process is neglected. I once asked a psychologist about his concept of mind. He had never given the matter a thought or been encouraged to do so in his training. We in medicine have no cause to feel smug, for we ourselves rarely examine some of our own basic assumptions. How many physicians have subjected to critical examination such everyday terms as health, disease, and illness?

A well-established discipline can often manage, at least for a time, without this critical examination of assumptions. A new and developing discipline must, if it is to survive, be based on a sound and well-constructed theory. If we are going to use terms like "continuity of care" and "the family as patient," we must say precisely what we mean by them and be aware of all their implications.

In the scientific aspects of family medicine the role of philosophy is to be, in Whitehead's[2] phrase, a "critic of abstractions." So far, family medicine seems to have accepted without question medicine's current system of abstractions, ie, its method of classifying diseases. We have done this even though it often fits poorly with the "brute facts" of general practice. We continue, for example, to perform morbidity surveys in which we accept without question concepts like "psychiatric illness." And we continue to find it very difficult to obtain results which are consistent from one physician to another.

I suggest that the next task for philosophy in family medicine is to re-examine our whole concept of illness and disease. Perhaps we are on the brink of a change of paradigm in medicine. If we are, then I suggest that it is more likely to come from family medicine than any other field, because it is in family medicine that we see most clearly the incongruities of our current system of abstractions.

Natural History

It is in this field that our progress has been disappointing. The defects in our knowledge become apparent when we begin to teach. What can we teach our students? We can teach them our philosophy and we can describe some of our methods. But where is our body of knowledge about the phenomena of family medicine: the natural history of common complaints, the norms of individual behavior at all stages of life, the description and classification of families?

Of course, we are not alone. Modern medicine has neglected clinical research. It is particularly serious, however, that family medicine should do so, for there is no branch of medicine more suited to observational research. Family physicians see the whole range of diseases from the mildest to the most severe; they follow illness from its earliest symptoms to its latest stages; and they observe patients in their natural habitat—a habitat which they often share themselves. To indicate the rich harvest awaiting workers in this field I cannot do better than quote a passage from a recent article by Spitzer:[10] "The family physician has a distinctive perspective and the obligation to study intact human beings in free-living, non-institutionalized populations over long periods of time, observing transitions from health to disease and back to health, with a unique opportunity to observe, on a firsthand basis, many of the concurrent phenomena that affect health and disease, such as family, employment, housing, and exposure to risk factors.

"Some subject areas that deserve high priority in family medicine research are calibrational studies focusing on clinical phenomena such as quantification of pain, quantification of the quality of survival, the development of explicit criteria for adequate clinical management of carefully defined conditions, demarcation of presenting complaints and their combinations as distinct from the demarcation of diagnoses, a taxonomy for behavior associated with disease or perceived disease, prognostic stratification of patients, and the calibration of the clinician himself as a reliable observer."

Anybody who peruses the family medicine literature will soon see that the task has hardly yet begun. Of all the papers published in *The Journal of Family Practice* since it started publication, how many are based on direct observation of clinical phenomena made by the authors themselves? We have studies based on the examination of records, we have review articles, we have papers on the description and evaluation of methods—all important and useful—but of research in the clinical science of family medicine, how little we have seen so far.

There is no doubt in my mind about the path to maturity: deep reflection on our modes of abstraction, continuing work on the development and evaluation of our tools, and the slow and steady accumulation of a body of data by meticulous clinical observation. Our immaturity is not a reason for despondency or shame; on the contrary it is a challenge which makes family medicine one of the most exciting of subjects. As Ravetz[1] concludes: "Immature fields with the hope of imminent maturation are, with all their attendant hazards, the place where the greatest challenge is to be found."

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