Letters

Impediments to the Acquisition and Use of Medical Knowledge

There are two ways of viewing the practicing physician. On the one hand he may be thought of as primarily a diagnostician, who, having identified a disease process, treats it in accordance with general recommendations originating in medical research centers. In doing so he takes into account certain parameters in the individual patient and modifies the suggested treatment accordingly. This view of the physician pertains to the concept of medical care as a public utility and to situations involving large numbers of patients and standardization of services, where variation in treatment due to variation in the intellectual and educational qualifications of the individual physician is minimized. The physician, viewed in this way, is essentially an engineer, exploiting general knowledge acquired through biological research.

Alternatively, the physician may be regarded as primarily an investigator attempting to understand the complex process of disease as it exists in each patient. As such, he is expected to theorize about, and to investigate, his problem (in this case, the human patient) and to introduce variation and innovation in arriving at a diagnosis and a plan of treatment. This view implies quite emphatically that disease and the means of modifying it are largely not understood and that regimentation of diseased individuals into broad treatment categories is a waste of scientific effort.

The first view implies a degree of uniformity in the patient population as well as a degree of diagnostic reliability as yet unattained in medicine. Individual variation in response to disease is too great to allow the practitioner to suspend judgment to the degree required. The future use of computers in medicine may make this approach more feasible as it forces greater uniformity in the collection of diagnostic data.

The second view implies that the practicing physician is a competent scientist—that he has a knowledge of medicine sufficient for making sound and responsible judgments. Both views, as stated, are idealizations, and a more realistic appraisal would recognize the need for a blend of the two. However, as between the two, I believe that the better situation results when the practicing physician recognizes that the diagnosis and treatment of disease has all the elements of an experimental situation—that is, observation, data collection, judgment or conclusion (diagnosis), and treatment on the basis of the conclusion (indirect verification). Whether the process is carried out well or badly is another question.

If we accept the idea that each physician is an experimenter (whether he realizes it or not) utilizing human beings as experimental animals, it follows that every advantage enjoyed by other experimental scientists should be available to him. The experimental scientist needs the best in research technology—the best in instrumentation, and skill in the use of the instruments. But in medicine there are arbitrary restrictions that have a detrimental effect.

Modern scientific technology demands corporate ownership and support. The cost of purchasing and maintaining equipment precludes individual ownership and control. In medicine, the hospital performs the function of the corporation. It owns and controls surgical equipment and operating rooms, tissue-processing equipment, facilities for performing autopsies, x-ray equipment, and an analytical laboratory. It also supports a staff of nurses and medical technologists.

The physician, to be a true investigator, should have ready access to each of these facilities. In addition, he should be fully informed of technical advances in each area and should have some skill in each. But in the existing situation this is not possible.

In science in general, the word *specialization* pertains largely to the area in which an individual is doing research. A specialist in one area of research must not be ignorant of large segments of the total field. Nor does the concept of specialization demand that one remain an amateur in other specialties; this is a matter of personal choice. Neither is the word used so narrowly as to apply to technical proficiency with a research tool; such proficiency is the hallmark of a technician, not a scientist. *Specialization* connotes specialized knowledge.

One might, if the term were used in medicine as it is used generally, regard all physicians as specialists in human zoology. But in medicine the word is used to define not the physician's research interest but the technical area in which he has been accepted by virtue of having completed an arbitrary apprenticeship. As such, the term is more in keeping with a classification of technician than of scientist. The rate of attainment of specialist status is fixed and does not permit variation to accommodate above-average capability. And the temporal requirements of the apprenticeship are such that completion of more than one course of training is not generally feasible. The few individuals who do complete more than one apprenticeship are restricted in practice to one specialty—another factor making broad specialization impractical.

Where the term is used to pertain to the use of tools, broad "specialization" is possible, though it may be prohibited. In medicine, *specialization* often refers to the *control* of something, be it the pediatric ward or the x-ray machine. Such control is exerted in the hospital and is established practice. For example, surgeons are involved with the instrumentation and techniques of surgery and they control the technical facilities, such as operating rooms, surgical equipment, and surgical staff. Radiologists control x-ray apparatus, and pathologists control necropsy and tissue-preparation equipment. Whenever an innovation in instrumentation occurs, a group of physicians soon springs up to control its use. The electrocardiograph, the cystoscope, and the pump-oxygenator are examples.

Medicine is at present practiced on a

fee-for-service basis. The more patients a doctor has, the greater his income is. It is financially advantageous to obtain control of some type of service, such as surgery. This enticement has been too strong for some elements in the medical profession to resist. The most outstanding example is the situation that arose between general practitioners who performed surgery and the rest of the profession. These men formed a clique and were instrumental in carrying out certain measures which contributed to the fragmentation of medicine. The most detrimental of these measures was a cut-off in the free flow of training and information in surgery to all practicing physicians who wished it. This was accomplished by creating arbitrary certification requirements which excluded "preceptorship" training (the surgical training of practicing general physicians) and demanded "residence training" (the surgical training of nonpracticing physicians who will limit their practice to surgery). Similar arbitrary prohibitions followed in the other technical specialties of medicine as a direct result of willful prohibitions not necessitated by the nature of medical science per se.

The scientifically oriented physician, as opposed to the technically oriented physician, has suffered a setback. His concern is the investigation of cases. In this he must be free to utilize every technical development available for collecting and handling data. But here he meets with certain obstacles.

The collection of data about a patient involves the use of a great deal of equipment. The more extensive the investigation, the greater the number of technical devices needed. Let us consider the removal of tissue from the body for diagnostic purposes, or x-ray procedures, or the inspection of body orifices and cavities. The physician investigator cannot personally remove tissue from a living patient, because, unless he is a surgical technician, he has not been taught to do so. Adequate instruction in surgical technique has been deleted from medical school curricula and internship training programs. A parallel situation exists in the collection of x-ray data. When inspection of a body cavity is necessary, the situation becomes more complicated: each orifice and cavity lies in the domain of a separate specialist—the bladder, in that of the urologist; the respiratory passages, in that of the thoracic surgeon; the anus, in that of the proctologist.

The storage of data is very important in medicine, since the investigator may come across cases appropriate for a particular study only over a long period. He should have on hand histologic slides of any tissue removed from any patient, plus x-rays and an accurate notation on observations, and these should be observations that he himself has made. Under the present mode of operation, however, the histology slides belong to the pathologist and the x-ray pictures belong to the radiologist, while the records of the physician investigator contain only a verbal description of another physician's observations. The investigator is one step removed from his data.

Since the specialized physician is unfamiliar with the technology of more than a narrow field, he cannot intelligently interpret the raw data yielded by techniques outside his specialty. No one person has, for example, the experience necessary for interpreting such diverse data as histological preparations, x-ray pictures, and evidence of pathological change in a body cavity. We have heard a great deal about an alleged explosion in medical knowledge and its importance in preventing any one man from gaining broad competence. However, it is not an explosion in knowledge but a willful decision on the part of those responsible for medical education that is responsible for the existing limitations in the training and experience of the individual physician.

Revision of the curriculum of the medical school, so that graduates will have broad technical proficiency, as well as academic competence, is long overdue.

RICHARD D. BALDWIN
*1 Montgomery Road,
Skillman, New Jersey*

Citations in Secondary Textbooks

Garfield's suggestions regarding citations in popular and interpretive science writing in the periodical literature [*Science* **141**, 392 (2 Aug. 1963)] may be extended to the textbook level. With all of the sciences becoming increasingly complex and the volume of research pouring from the technical journals threatening to engulf us, the role of the textbook writer as a literature abstractor is becoming increasingly important. For a variety of reasons, not the least of which is inadequate preparation of teachers in subject matter, the need for, and value of, citations in textbooks is probably greatest at the secondary level. And yet such texts seldom have adequate documentation. Citations in secondary textbooks to the more important popular articles and original research papers, and even the judicious use of research papers themselves in the class, might produce some startling results. I am convinced that secondary students can be trained to use documentation at a much earlier period than generally supposed.

ERNEST J. ROSCOE
Raymond Foundation, Chicago Natural History Museum, Chicago, Illinois

Use of Names in Concept Formation

I question the conclusions Ranken has drawn from the experiment on "Language and thinking" [*Science* **141**, 48 (5 July 1963)]. The construction of his experiment almost preordains the outcome. By assigning a different name to each of his eight figures, he tends to create a set in the subject that obscures the similarities of the figures. As a result, those subjects that were asked to form imaginal representations were given an advantage over the others in the jigsaw problem. In addition, Ranken is only assuming that the group that was instructed to form imaginal concepts did, in fact, do so. I feel that a highly verbal person would, in spite of his best intentions, tend to verbalize the shapes.

If a similar experiment were to be performed in which the names recognized the similarities of the shapes, the outcome would be very different. For example, each of the eight shapes is made up of two of four discrete contours. For the purpose of categorizing let us give each of the shapes a pair of names—the first name would indicate the top contour; the last name, the bottom. Even if the subject is not told of the similarities of the shapes, the names will now cue him to recognize these similarities. If he does notice the similarities, the jigsaw problem becomes trivial once the names have been memorized. The subject merely fits the names together as simply as he would fit the actual shapes together.

Of course, the preceding experiment