increase in the arbitrary indirect-cost limits placed upon many research grants (limits already inadequate according to the government's own auditing procedures set forth in the famous circular A-21), we at Washington University were forced by the new NIH regulations, which call for much more paper work and reporting, to squeeze additional business office staff into an already strained university budget and into severely cramped buildings. We do encourage the development of greater research activity in parts of the university, but for academic reasons relating to the program. We do this in spite of overhead losses that will be incurred.

Fosberg is correct in contending that research is a fundamental function of any university worthy of the name. That question is not at issue. What is at issue is whether, if I were faced with making a university budget in the absence of indirect cost allowances for sponsored research in science, I would be helping the nation and higher education as I chose between two alternatives:

1) Squeeze the humanities, the arts, and most professional programs in the university in order to try to keep the costly science projects afloat.

2) Drastically curtail the university's participation in science research and in the training of research scientists.

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For some months I have been adding to my reviews of grant proposals a statement such as this (taken from a June 1963 proposal): "Computation of indirect costs at 25 percent seems excessive. I recommend that the sponsoring institution be invited to substantiate its claim that institutional support of this program will cost over $14,000." The project which brought forth this particular comment was in systematic biology for a 2-year period. The research budget items were about 75 percent for salaries, 15 percent for publication of results, 9 percent for travel, and 1 percent for expendable supplies. How could it ever cost $14,000 to administer such a program?

It would be in order for project reviewers and panel members to question excessive overhead charges.

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Specialization in Medicine

In attempting to answer Baldwin's indictment [*Science* **141**, 1237 (1963)] of specialization in medicine, I must begin by assuming that he is seriously interested in the welfare of patients and in the advancement of biological and medical knowledge.

Specialization in medical practice and medical research has not been all to the good, and it has probably stifled the creativity of a certain number of virtuosi in these fields. But it certainly has not been instigated or nourished by the venality and willfulness of the medical profession, as stated so bluntly by Baldwin. Nor is it a negative phenomenon, as he would urge us to believe by his choice of adjectives throughout his letter.

First of all, during the medical-school training of a physician there is no specialization. From the basic scientific years through his clinical training, medical educators expose him to all facets of biological and clinical knowledge. At the end of this 4-year period of education and training the poor fellow really begins to learn what medicine is all about.

The technical side of the practice of medicine, as a service to patients, is a matter of technical competence in gathering data, evaluating it, arriving at conclusions, and finally, taking action. Of course, in addition to this "biological engineering" there is the added problem of "human engineering"—the relationship of the physician with his patient and with society—but discussion of this important matter does not seem pertinent to Baldwin's comments.

Unless he is disoriented, the budding physician will find out sooner or later what Baldwin denies—namely, that there *has been* an explosion of medical knowledge, and that while he may encompass it in theory, it is impossible for him to become skillful at applying it all in practice. Most chastening is the realization that there is no such animal as a brilliant "young" doctor. We have brilliant young men who are doctors, but it takes a finite period of time for them to become brilliant doctors, at the end of which time they are older.

During this period of professional maturation a real physician inevitably recognizes that there is not enough time for him to become skilled in all the ways of examining and manipulating the human body and mind. In particular, there is not time for him to learn enough in each discipline so that he can conscientiously trust his own judgment and take moral responsibility for his actions in all of them.

That is why the budding genius suffers the urologist to peer into the patient's bladder. He knows that this consultant's "narrow" but high-powered background of apprenticeship makes him more competent in data-gathering and decision-making about people's bladders. Similarly, the pathologist who has suffered agonies of decision-making over his microscope in hundreds of bladder biopsies has the clearest right to be trusted with the decision as to whether the disease is benign or malignant. And finally, whom will Baldwin call in to operate on his own bladder—the narrow but skillful chap who has proved he can do the right thing on purpose in a hundred bladder problems or the genius who cannot possibly do the right thing, even by accident, when he has a total experience of one case each in a hundred different surgical procedures?

I do not know why Baldwin interprets an explosion of competence as no explosion at all. Perhaps he prefers the separate plodding of ten dilettantes to the coordinated plodding of ten experts. Maybe he has heard somewhere that sometimes physicians have ego problems and prefer to work alone. Perhaps he is annoyed by the fact that the scientific aspects of medical care are getting more rational and more salutary each day, instead of falling apart, as our detractors would like to believe. It certainly has become fashionable to accuse physicians of selfishness, ignorance, and shortsightedness, and this Baldwin has done in full measure. In any event, it is good to know that in a country with notably high standards of medical education, of medical care, and of medical scientific achievement, there are those who care enough to write.

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Baldwin propounds inaccuracies concerning both theory and practice. I will limit my discussion to his comments on radiology, about which I have some personal knowledge. As far as I am aware, all medical-school curricula include radiology. There are many institutions offering post-graduate instruc-

tion in this field. There is no legal or medical restraint which prevents a physician from making x-ray examinations. He can limit himself to what he thinks are simple examinations, or he may tackle any and all cases. In fact, hospitalization plans like Blue Shield would, I am sure, show that many if not most payments for x-ray examinations are made to physicians who are not radiologists. This immediately demonstrates either that Baldwin is uninformed or that a large number of physicians perform examinations for which they have no training or experience. I will let Baldwin choose which alternative applies.

Baldwin says that the "true investigator" (that is, investigative physician) should have ready access to radiologic data. He does. I cannot imagine that a physician would be denied the privilege of seeing the films made of his patient. The radiologist asks only that the films be returned to him as part of his record, if only for legal reasons. Baldwin says this places the investigator "one step removed from his data," but surely this is not a very large step. More important, however, is Baldwin's statement that "no one person has . . . the experience necessary for interpreting such diverse data as histologic preparations, x-ray pictures, and evidence of pathological change in a body cavity."

I could not agree with him more fully, but while he infers that medical educators could turn out such an individual, I do not think they could. I believe the interpretation of the raw data requires a maximum of specialized training and experience. I believe the generalist has every right to inspect the raw data, weigh them (along with the interpretation) and correlate them. This is "academic competence," as Baldwin uses the term, and the generalist surely should find this fully occupying and fully satisfying. The specialist has technical proficiency because he has spent many years of full-time attention acquiring it. There is nothing to prevent the generalist from acquiring this proficiency if he will spend the necessary time.

Baldwin states, "It is financially advantageous to obtain control of some type of service." As I have indicated, he cannot be referring to the private practice of radiology, because the radiologists do not control this. In the hospital, to allow every generalist to perform the technical operations of radiology on his patients would lead to bedlam, even if he were technically proficient.

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Sussman's comments are not primarily concerned with corporate medical facilities, the substance of my original letter. Hospitalization-plan payments for in-hospital radiology services would show that virtually all such payments go to radiologists.

Rogoff asserts the existence of knowledge which may be encompassed in theory but not applied skillfully. Is he really speaking of knowledge? He links such words as *narrow* and *high-powered, narrow* and *skillful.* For the sake of mild rebuttal allow me, with the same justification (or lack of it), to link *broad* and *skillful* and *broad* and *high-powered.*

In my original article I stated that the technical facilities necessary for the investigation and treatment of disease are, of necessity, corporately owned. How and by whom this property is to be used is determined by the corporation. Corporate medical facilities are divided into discrete categories called medical, surgical, obstetrical, pediatric, and so forth. Each of these subdivisions or "pigeonholes" is administered by a group of physicians. There is no overlap.

The question arises, How well does such a situation serve the needs of doctors and patients? According to one prevalent view, the patient is handled like a bucket in a bucket brigade, being passed from one compartment to another, receiving the combined attention of several groups. While pigeonholing may be administratively sound, providing one means of avoiding "bedlam," and while it may at the same time provide a good quality of medical service, it has definite unfortunate consequences. Disease does not respect present pigeonhole boundaries, and neither can the serious student of disease. Perhaps some of Sussman's and Rogoff's objections stem from a basic confusion regarding the difference between a student of disease and a student of radiology.

Rogoff lightly dismisses the importance of venality as a determinant in medical affairs. To do so, I am afraid, is totally unjustifiable. "Specialization" properly pertains to areas in which one maintains a lively research interest; in medicine it denotes that one belongs to a group which controls corporate facilities.

How does one maintain control? One way is to control information and training. Rogoff states that, "at the end of this 4-year period [of medical school] . . . the poor fellow really begins to learn what medicine is all about." This is an implicit definition of premedical education. The proper task of medical education is the transfer of sufficient medical information and skills from a library to medical students to enable them to practice medicine.

If a large part of this transfer is neglected by the medical schools there is indeed an impediment to the acquisition of medical knowledge. Some specific impediments are the forceful focusing of the students' attention on handbook data and de-emphasis of broad conceptual understanding; a total disregard of training in surgical techniques (including orthopedics and gynecology); the lack of laborataory courses in the clinical sciences; the lack of problem exercises in any of the medical sciences; the failure of the medical schools to take responsibility for training in the technical aspects of medicine and their allowing this phase of medical education to be picked up as best it can be in residency training programs; and the general lack of investigational experience for medical students. This state of affairs is a burden to all who would be, and all who are, physicians.

The "knowledge explosion" is a figment of the imagination, proposed for rationalizing this unfortunate state of affairs, on the grounds that all that can be done is being done in the face of a hopelessly large amount of information to be passed on. While I will not dispute the fact that medical knowledge is advancing, nor that there has been an explosion (if you will) in biologic data, I do feel that the assertion that there is a knowledge explosion is highly presumptuous. While it takes a great deal of time to obtain data on a given topic, it fortunately takes less time to expound the knowledge so obtained. Paradoxically, the data explosion simplifies the task of the medical scholar by replacing ignorance, doubt, and some dubious theories with more rational explanations.

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