Papers and Originals

Fifty Years On*

Sir MACFARLANE BURNET,† O.M., M.D., F.R.C.P., F.R.S.

Brit. med. J., 1964, 2, 1091-1093

To anyone with a little imagination and some hobby-horses to ride, an invitation to speculate on medicine 50 years hence is quite dangerously attractive, especially if one believes, with Bertrand Russell, that to care intensely about what will happen after one is dead is the mark of a civilized man. There are obviously two approaches. The pessimist may look at all the things that have happened in the last 50 years and consider to what depths the logical continuation of those processes may lead us by the year 2014. The optimist will think of the potentialities that have been brought to reality since 1914 and dream of an equivalent advance in the conquest of disease, disability, and pain in the next 50 years.

My approach will be mainly on the side of the optimists. What will emerge from it will be essentially a realization of the growing and necessary diversification of skills within the medical profession and its progressive implications for the structure of medical care and for the pattern of medical education.

Even to-day individuals with medical degrees are concerned with dozens of professional activities with hardly any overlap. There is very little in common in the responsibilities of an administrator of state health policy, a psychiatrist, a consultant physician, an orthopaedic surgeon, a lecturer in anatomy, a Ph.D. candidate in physiology, a junior hospital resident, or an immunologist directing a research institute. But all of us are "doctors."

When we look forward 50 years this diversification of professional activities is bound to continue, and our main responsibility to-night is perhaps to consider whether the education and organization of the profession can be kept in step with such changes, to ensure that the community continues to receive optimal or, at least, adequate medical care at reasonable cost. What I am going to say is based on the assumption that our primary objective is simply to provide the most effective treatment for the patient, defined as the treatment which soonest allows him to take his place again as a productive unit in the community. This, of course, is an undue simplification. I am quite aware of the problems centred on the social status and financial reward to the doctor, on the one hand, and the even more difficult ones that arise from the more or less indefinite postponement of death in incurable and economically ineffective individuals—but for this talk we can, for the most part, forget about these complications.

In the very broadest terms, medical care involves: (1) the realization by the patient, or his associates, that something is wrong; (2) the process by which a doctor assesses the nature of his complaint; (3) definitive treatment of the condition.

Again, in the most general terms, the conditions that lead people to call on a doctor for help fall into four categories: (1) life-threatening disease or injury that calls for full hospital investigation and treatment; (2) disabilities calling for some form of surgery or prosthesis; (3) symptoms, etc., requiring

diagnosis, reassurance, and/or domiciliary treatment; (4) socially dangerous conditions requiring special action, such as insanity and certain types of infectious disease.

From such a formulation two key processes emerge: the primary recognition of medical need and the decision as to the type of management called for—what we may call the function of the doctor of first contact—and second, the application of scientifically based medicine to the relief of the patient's condition—already largely and, in 50 years' time probably wholly, the function of the hospital.

Doctor of First Contact

I prefer to use the phrase "doctor of first contact" rather than "general practitioner," because I feel that eventually the doctor of first contact may have a very different range of skills and activities from those of the classical general practitioner of my younger days. His most important function, however, will be, as now, to decide whether the condition presented by the patient calls for hospitalization or its equivalent, and to steer the patient to where his needs can best be met. Every development in medicine suggests that the doctor of first contact will have no responsibility for hospital treatment. One pictures him as essentially a wise counsellor, with a special quality of understanding the whole predicament of his patient, and a wide range of social, psychological, and medical expertise to help bring him back to full effectiveness in the community.

He will be responsible for those forms of manipulation and treatment that can be effectively handled outside the hospital environment and for which satisfactory control is possible without specialized tests. The number of such activities may well increase steadily with the stabilization of medical knowledge. Once adequate clinical research has laid down the potentialities and limitations of some new procedure, it is common for it to move from the hospital to the doctor of first contact. Then, as now, such a practitioner would have ample opportunity to use every faculty he possessed, and, I should guess, will attract more of the respect and liking of his fellow men than the scientists and specialists in the hospital.

Hospital

Hospital medicine is already taking the shape that it will have in 50 years' time and perhaps definitively. Most academic departments of medicine and surgery would probably define their function as the application of biological science and,

* Read at a meeting of the Victorian Branch of the Australian Medical Association on 5 August 1964. This paper is appearing simultaneously in the *Medical Journal of Australia*, whose Editor has kindly agreed to its publication here.

† Walter and Eliza Hall Institute of Medical Research, Melbourne, Australia.

particularly, of biochemistry to the prevention of death and the recovery of health. The hospital is where most people die, and it may be that the process of death has unduly influenced the development of hospital medicine. The process of dying is a biochemical one, and, with appropriate control of biochemical parameters with artificial organs, intravenous therapy, etc., death can almost always be postponed. In many cases that postponement will allow eventual more or less complete recovery; in others it may pose the characteristic modern dilemma of how long one is justified in prolonging an existence that is nearly intolerable to the individual and a profitless drain on the community's resources.

Potentially lethal disease is to-day treated in a modern teaching hospital on the basis of the observable biochemical findings. Prognosis and the detail of treatment are guided by quantitative data plus other observations which are not yet fully expressible in quantitative form. Clinicians can justly claim that their handling of the patient is based wholly on the application of known rules to the objective findings on the patient's condition.

This raises what may well become the characteristic feature of hospital medicine within the next 50 years, the progressive transfer of decision-making to data-processing machines, or various types of computer. I can see no escape from the contention that if judgment is to be based on experience, then a machine which can give accurate weight to all the relevant information and express the judgment in terms of a quantitative probability will give a more acceptable answer than any clinician. There will be a long process of technical development before the machines can do more than touch the fringes of medicine. I suspect that, for many purposes, the elements of the situation will be displayed as a pattern on an oscilloscope rather than a definitive order for such and such a treatment. It will still be for the physician to interpret the pattern, but this time he will know that all the measurable data have been given due weight. His decision as to appropriate action may still be shown by the event to have been right or wrong, but he will also know that, with every case, the basic data to be stored in the system's memory will be so much more reliable.

Surgical and other types of specialized treatment will require the same type of special skills as at present, but the indications for action during the course of disease and convalescence are almost certain to be derived from machines. Automated biochemistry and electrocardiographic monitoring are a present forerunner of things to come.

The process has already begun in medicine as in every other high-level human activity, from making decisions between war and peace, to weather forecasting and booking airline seats. The brightest academics in medicine will soon be more interested in mathematics and cybernetics than in to-day's fashionable molecular biology, or the microbiology that was the excitement of my day.

Without attempting to go any farther in spelling out the hospital situation, we can see that the requirements for hospital medicine are going to be completely different from those needed by the doctor of first contact. Logically, quite different approaches will be required for their professional education. In particular, there will be need of men who are much more mathematicians and biochemists than physicians, in our present sense of the term, but who will also need to apply common sense, courage, and compassion in handling all the human difficulties that escape the machines. The need for an increasing army of specially trained technicians within the hospital will be obvious, and for many of these there may need to be an upgrading of status which will bring them the same responsibility and prestige as used to be reserved for operating surgeons alone.

This leads us to my final topic, which interests me more than all the rest—how are we to educate young men and women to be doctors of first contact, hospital computer executives, neurosurgeons, biophysicists, and the like?

Education for Medicine

Any man practising medicine has a vast fund of knowledge relevant to his professional activities, but in that fund there is relatively little of what he learned in medical school, and his use of modern medical science is essentially empirical. Professional education will never be concerned with teaching the student what to do in regard to the actual situations he will have to deal with in 10 to 40 years' time. It is concerned to train his power of understanding such problems by education, in depth, in some chosen relevant fields, to give him a more superficial but broad knowledge of the existence and character of other relevant areas, and to provide him with the ability to use the literature of his subject, postgraduate education, and consultation with his colleagues so as to make the most effective practical contribution to the community's needs.

In my day, anatomy, physiology, and morbid anatomy were what we studied in depth. To-day, my impression is strong that the medical student is educated in depth only in biochemistry. Other subjects, apart from their biochemical content, tend to be regarded as relics of the past.

Medicine must be based on biology, and specifically human biology. Nowadays we can study human biology from many different angles—the problem of medical education is, from my point of view, at what particular levels of biology should education be in depth? In Table I I have tried to indicate the logical approach to human biology, irrespective of whether we are thinking about general education or the training of the medical student. There are, I believe, five levels at which any

TABLE I.—Divisions of Human Biology

Levels of Study	Aspects of Study and Relevant Type of Medical Activity
1. The species ..	Evolution, ecology, social sciences (Epidemiology)
2. The individual ..	Nutrition, reproduction, behaviour (Psychiatry)
3. Functional anatomy ..	Anatomy, physiology (Surgery, pathology)
4. Cellular dynamics ..	Differentiation, immunology (Oncology)
5. Molecular biology ..	Biochemistry, biochemical genetics (Metabolic disease)

type of living organism can be studied, and against each I have indicated the particular type of medical activity that is relevant: (1) The species: ecological, genetic, and social aspects. (2) The organism as a whole: behaviour, reproduction, nutrition. (3) The functional anatomy of the body—classical anatomy and physiology. (4) The cellular differentiation of the body and the population dynamics of the body cells. (5) Molecular biology, biochemistry, and ionic physiology.

Each of these five levels is important, each has been and can be studied in depth and detail, but, equally, each can be usefully described, abstracted, and simplified (in the light of modern knowledge) to give adequate practical guidance in dealing with day-to-day problems, without training in depth.

The problem of how to educate the medical student is only one facet of the general problem of educating the young for their most effective functioning in a modern community. If we, for the time being, confine ourselves to persons who will receive tertiary education we can make certain suggestions.

1. All educated people should be aware of those aspects of human biology which are relevant to their understanding of the human situation and for maintenance of their own health.

2. All responsible members of the medical professions require an education which provides an effective coverage of all aspects of human biology with more emphasis throughout on the pathological side, and, with training in depth in some area, of special significance for their future orientation in medicine.

3. All professional workers will need postgraduate training in specific techniques and in the general process of remaining effectively up to date.

I believe that such an approach will call for considerable changes in medical education before we are far into the twenty-first century. It is time already that the old-fashioned academic ideas of the sort of education needed in common for all doctors should be scrapped. I have given a list earlier of the different levels of human biology, and I believe that an honest education in depth in any one of them would provide the necessary background for the whole life process of education which is the essence of a real profession. In my undergraduate days I was taught nothing about the experimental virology and immunology that was to be my life's work, but, in one way or another, from Orme Masson, W. A. Osborne, R. R. Stawell, and a few others, I did obtain an education in depth that allowed me to build up my own picture of man as the current edge of the evolutionary process—no more and no less—which has been behind everything worth-while that I have done or written. For everyone two things can come from a good education—the ability to handle ideas and situations and a sense of the things that are important. At the present time I believe that the current prestige of academic laboratory research, especially in molecular biology, is inducing a sense of values which is quite unsuited for more than a tiny fraction of medical graduates. I hope to see a new approach which will allow each initiate to medicine to choose his own area of intensive study—and especially to allow those who, from their interest in human beings rather than in ideas, will be the best doctors to concentrate on the behavioural sciences rather than on the laboratory ones.

In Table II I have made a suggestion as to the sort of approach to tertiary education for medicine that I believe will have to emerge during the next 40 or 50 years. There is no

TABLE II.—*Education for Medicine*

Human Biology	Doctors of First Contact	Hospital Personnel		
		Adminis- trator	Physician	Specialist
1. Species	+	+++	+	+
2. Individual	+++	++	+	+
3. Functional anatomy	+	+	+	+++
4. Cellular dynamics	+	+	++	+
5. Molecular biology	+	+	+++	+

detail whatever in it, but it contains everything that I should like to leave with you from this talk:

1. That medicine must become progressively more diverse, but that it must always be firmly based on human biology.
2. That education in depth is practicable only in an area that directly interests the student; but that, with modern knowledge and techniques of communication, perfectly adequate performance can be obtained, even in professional fields, after quite superficial education.
3. That, for large groups within the profession and especially for the doctor of first contact, education in depth will be or should be concentrated on the behavioural sciences, the sciences that deal with the individual as a whole.

Medical Investigation of Retinal Vascular Occlusion

C. J. ELLIS* ; D. B. HAMER* ; R. W. HUNT* ; A. F. LEVER,† M.B., B.SC., M.R.C.P. ; R. S. LEVER* ;
W. S. PEART,‡ M.D., F.R.C.P. ; S. M. WALKER*

Brit. med. J., 1964, 2, 1093–1098

The present paper reports the medical investigation and follow-up of 146 patients with occlusion of retinal vessels (106 venous, 40 arterial). In most of the more recent reports of the condition (Jensen, 1936; Braendstrup, 1950; Duff, Falls, and Linman, 1951; Cassady, 1953; Klien, 1953; Anderson and Vallotton, 1955; Stephenson, 1956; Wise, 1957; Law, 1957; Tiburtius, 1960; Vannas and Tarkkanen, 1960; Thorne, 1961) the emphasis has been on the ophthalmic rather than the associated medical features. Liversedge and Smith (1962), however, reported the medical investigation of 63 cases of retinal artery occlusion.

Clinical Material and Methods

During 1961–3 146 patients with retinal vascular occlusion were seen in the medical clinic at the Western Ophthalmic Hospital. All cases were referred by an ophthalmologist, by whom the diagnosis had usually been made. For the most part patients were not referred on account of medical complications.

Cases with diabetic or hypertensive retinopathy or with macular degeneration were not included in the present series unless associated with a definite vascular occlusion. A small number of cases with Eales's disease or periphlebitis retinae were also excluded.

During 1963, where possible, all patients were asked about their smoking habits. These were divided into the six categories shown in Table I. Patients smoking both pipe and cigarettes were arbitrarily placed in the appropriate cigarette-smoking group. A history of smoking habits was obtained in 133 of the 146 cases.

TABLE I

	Retinal Vein						Retinal Artery					
	Occlusion			Controls			Occlusion			Controls		
	F	M	Total	F	M	Total	F	M	Total	F	M	Total
No history available	3	6	9				2	2	4			
Cases excluded ..							4	4	8			
Patients who had never smoked ..	24	9	33	32	6	38	2		2	6	3	9
Ex-smokers ..	6	8	14	7	13	20	2		2	2	6	8
Pipe smokers ..		4	4		4	4		2	2		0	0
Cigarette smokers up to 9 daily ..	11	4	15	8	4	12	2	2	4	1	1	1
10–19 daily ..	9	12	21	4	6	10	3	7	10	1	4	5
20+ ..	3	7	10	2	11	13	1	7	8	1	4	5
Totals of included cases ..	53	44	97	53	44	97	10	18	28	10	18	28

Control Groups

During 1963 the age, occupation, smoking habits, ophthalmic condition, and blood-pressure of 338 unselected ophthalmic patients were recorded. This control series was similar to the

* Medical Student, Medical Unit, St. Mary's Hospital, London.

† Lecturer in Medicine, Medical Unit, St. Mary's Hospital, London.

‡ Professor of Medicine, Medical Unit, St. Mary's Hospital, London.