Some Problems in Medicine that Present a Challenge to Technology

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In the 20th century, life expectancy in the industrialized sections of human society has risen from about 50 to 72 years. Perinatal and infant mortality have been drastically lowered, and the age-distribution pattern has changed radically.

These results were achieved by the application of a fairly small number of technical advances.

1. The use of safe and potent vaccines and antitoxin preparations assured survival and healthy development during infancy and childhood.

2. The extensive use of chemicals to kill bacteria or halt their growth, especially since the early 1930's, practically eliminated the threat of septicemias, bacterial pneumonia, tuberculosis, and rheumatic fever, and made possible certain major surgical procedures without the great risk of fatal infections.

3. Extensive surgical repairs, reconstructions, and resections became feasible because of blood transfusions in bulk without the risk of infection or immunological reaction.

4. A greater variety of safer anesthetic and analgesic agents permitted the use of diagnostic and treatment methods to be carried out with much less risk to the patient.

5. More detailed knowledge of kidney and liver functions and an understanding of metabolic needs permitted the use of fluid and nutritional replacements to maintain and strengthen the body's defense mechanisms.

6. Proper use of certain insecticides interrupted the life cycle of pathogenic parasites and thus led to checks upon diseases such as malaria.

7. The development of safe and accurately controlled radiation devices provided powerful diagnostic tools, as well as palliative and often more definitive treatment measures for malignant disorders.

8. The recognition that many bodily processes are regulated by chemical messengers—the hormones—has spurred their use in specific endocrine disorders (diabetes, hypothyroidism, menopause) and in "stress" situations.

9. Preventive medicine benefited greatly from the demonstration of the necessity for the ingestion of essential nutrients (vitamins, minerals, essential aminoacids, fats).

Thus the benefits have been many and the results rather spectacular. However, when we consider our present major health problems, we find that the very achievements of the last 75 years have to a significant extent generated or uncovered the problems of today.

The improving survival rate and the gradually aging population, which is the hallmark of the nutritionally adequate or affluent societies of today, have placed heart disease in general, and coronary arteriosclerosis in particular, in the forefront in both the mortality and morbidity categories.

Progressive hardening of the arteries (arteriosclerosis) is the end result of a host of interlocking factors: (1) familial predisposition; (2) inherited patterns of fat (lipoprotein)

transport and disposition; (3) high blood pressure; (4) environmental chemicals such as those arising from smoking; (5) the diabetic state; and (6) excessive fat deposits. Hypertension and diabetes, each in its own fashion, affect the structure and function of the kidneys and of the retinas of the eyes. Ultimately a significant percentage of kidney failures and of adult cases of blindness are traceable to these disorders.

It is evident that the so-called degenerative disorders are not easily partitioned into distinct, neat disease classifications. They develop over a long period of time. The generating forces are multiple. Symptoms arise only in gradual fashion. And the damage may be irreversible when detected. The medical facets of aging in general are, of course, related to the state of the heart and of the blood vessels and to the gradual deterioration of metabolic control systems.

Another group of catastrophic health hazards consists of the malignant growths arising from the blood cell systems and from the cells of the solid organs. Again, we are faced by an involved process that is influenced by a variety of factors and develops slowly: (1) familial predisposition; (2) environmental tumor-producing chemicals; (3) latent tumor-producing viruses; (4) repeated local injuries; and (5) hormones with specific proliferative powers.

The third most significant health problem in our society consists of the fatal, near-fatal, and disabling accidents on the road and in homes and industrial establishments.

The fourth large category of dis-ease belongs to the disorders of motor, sensory, and personality control and integration systems: neurological and psychological malfunction. While these disorders do not loom large as causes of mortality, they account for a major portion of all our ills.

Last, in this general classification, are the genetic disorders—that is, diseases in which the genetic transmission of a biochemical or structural defect forms the core of the problem. These disordered bodily functions are looming ever larger in our time because medical progress has allowed significant survival into adolescence and adulthood.

The splendid and rapid developments of modern biology during the last 30-40 years have already increased our understanding of some aspects of the medical problems we face. Our diagnostic measures have improved greatly; the categorization of disease is now on a firmer biological basis. However, the knowledge of causal mechanisms or of effective therapeutic approaches has not kept pace.

Medical progress since 1900 was achieved in the main by the technology derived from the scientific advances in microbiology and chemistry of the previous 75 years. We are, I believe, now confronted with the need to mobilize the forces made possible by present-day understanding and the techniques of chemistry, electronic engineering, information theory, and molecular biology to the formidable task of prevention and treatment of heart and blood vessel disease, cancer, the metabolic disorders, the disorders of the nervous system, and the more direct genetic disorders.

Major tasks in this continuing fight are the attempts to solve a set of difficult, but accessible, problems:

1. Organ transplantation without rejection.

2. The successful miniaturization of artificial organs or of functional organ parts, such as the kidneys, pancreatic islets, and peripheral sense organs.

3. An understanding of the pathological effects on the structure and behavior of cells and tissues of small but cumulative control errors—the effects of hypertension, hyperglycemia, and hyperlipidemia, for example, over a span of years.

4. The production and use of artificial biocatalysts which would *not* generate immune reactions.

5. The devising of control mechanisms for the extension or substitution of peripheral nerve functions.

Because these problems are so complex and require expertise in so many fields, their solution could be greatly hastened by the conscious formation of laboratory and hospital groups consisting of clinicians, biologists, and engineers who would study each facet jointly, in depth. Such groups have rarely functioned in a cohesive fashion, but more often as individuals "consulting" with each other. The results have not been satisfactory. What seems necessary is a concerted, joint, continuous effort with proper communication across the barriers set up by the technical jargons and traditions of each field. Out of such groups should evolve not only some immediate solutions to diagnostic and therapeutic problems, but also a better definition of the gaps that exist in basic scientific information. This should provide potent stimuli to basic research in the biological sciences.

I may be justly accused of undue and unrealistic expectations that solutions to the ravages of heart disease, cancer, and other degenerative conditions could come from application based upon partial knowledge. But this has always been the case. In my own field of medical practice, we learned to treat diabetes and gout in fairly satisfactory fashion before we understood the underlying biochemical mechanisms. The progress in basic endocrinology and metabolism was in turn immeasurably stimulated by these therapeutic successes. Let us hope that this principle will hold true for some of the health problems of today. □