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THE PUBLIC AND THE CANCER PROBLEM[1]

By Dr. JAMES EWING

DIRECTOR, MEMORIAL HOSPITAL, NEW YORK

PUBLIC interest in the cancer problem is now at the highest point in history. Evidences of this interest appear on all sides and many occasions. The radio audience listens to grave references to cancer about as frequently as the average public taste for reality will endure. In one state ninety radio talks on cancer were delivered in one week. Nearly all classes of magazines find that their clientele will accept some, even several, serious discussions of cancer every year. In the yellow journals and so-called health magazines preposterous tales about the nature and cure of cancer are eagerly consumed in proportion to the unintelligence of the readers, while the emotional susceptibilities of the ignorant are fed by hideous devices depicting the ravages of the cancer dragon. Pseudo medical journals not infrequently decry against the standard methods of treatment of the medical profession and lay open a broad field for the exploitation of the public by numerous cancer charlatans. Many books, some serious, others incompetent, attempt more comprehensive messages mostly on the nature and social significance of cancer, but an adequate popular treatise on cancer yet remains to be produced and is urgently needed.

While the public interest rests ultimately on human experience with the disease, the radical change in public sentiment during the past twenty-five years and the advancing standard of general knowledge are largely due to the efforts of the American Society for the Control of Cancer, and other similar organizations in other countries, which have labored systematically and rather effectively to spread the knowledge of the main facts about cancer, emphasized the necessity of early diagnosis, stressed the warning signs of the major forms of the disease and in every way endeavored to establish an intelligent progressive attitude toward

[1] Evening Lecture before the National Academy of Sciences, Washington, April 25, 1938.

the cancer problem. This society has now built up local branches in every state and in most large cities of the country, and has contributed to the aroused interest in cancer as a public health problem by city, state and federal health agencies. It has so far failed to reach any considerable proportion of the non-reading public, but advances into this territory are slowly being accomplished by discussions in public schools and in some cities by personal canvasses of the lower classes conducted mainly by women. Women have always taken a prominent part in the movement for the control of cancer. The successful organization of the Women's Field Army of the American Society, bringing together over 100,000 women in one brief campaign, is an impressive illustration of the power of organized effort, especially by women, in public health movements. The Women's Field Army is one of the most significant efforts yet made in the history of cancer control in this or any country, and promises results of much significance. It is the privilege and duty of every intelligent woman to join its ranks.

Notwithstanding all past efforts the public knowledge of the practical aspects of cancer is still very superficial, tinged with emotion, distorted by unwarranted fear, restricted by inherent complexities of the subject and definitely limited by its obscurities, but it is steadily improving. Already in some localities the death rate from some forms of accessible cancer is beginning to decline, as a result, one may believe, of advancing public intelligence. Within the medical ranks there is a similar record of aroused interest, and more serious recognition of the scope of the cancer problem and of the variety and complexity of the agencies which must be set in action before one may speak of cancer control. The last 35 years have seen the growth of an immense, well-codified and rapidly circulating technical literature, the organization of local, national and international cancer societies and congresses, the systematic presentation of cancer programs in important medical meetings, improvements in the facilities for cancer service in general hospitals, the erection of broadly organized cancer institutes in many cities. An entirely new and comprehensive science, radiology, has been brought into existence, and is being applied through a vast number of competent specialists and a complex and elaborate machinery with startling new and beneficent results in the diagnosis and treatment of cancer. Perhaps the most significant change in the attitude of the medical profession is the present frank recognition of the deficiencies of medical knowledge about cancer and its treatment, as well as delinquencies in the application of well-known facts, and the general conclusion that effective study and treatment of cancer may no longer be considered the occasional task of the general practitioner or surgeon, but constitutes a highly complex medical specialty. Indeed, it may safely be said that cancer has become recognized as one of the most important and most progressive departments of medicine, as it is also the most fundamental problem of biology. This is the age of cancer progress, and since medical eras do not last indefinitely the medical profession is resolved to maintain at the highest level the momentum now gained in this field.

Accordingly, medicine is now calling freely for aid from the sciences, and if one surveys the organization of the modern cancer institute one finds representatives of many branches of science, physics and biophysics, chemistry and biochemistry, biology and genetics, botany and zoology, pathology and bacteriology, as well as all branches of medical art. In addition, the operation of a well-ordered cancer hospital involves not a little attention to statistical science, psychology, economics and sociology. These ramifications of the interest in cancer, which reach into many branches of human knowledge, form a broad basis which assures sound progress, but at the same time become a definite menace, because when every type of investigation claims relation to cancer, the resources become dissipated over too vast a territory and are apt to lose practical value. Since all classes of the public, educated and uneducated, professional and lay, scientific and political, have become more or less cancer-conscious it is not a matter of surprise that governments, state and national, have been taking a serious interest in the problem and have devoted large sums of money to cancer projects, creating special departments for study, service and research, and even in some instances showing a modern disposition to take command of the whole movement. Indeed, the present status of public interest in cancer has now reached a stage of emotional excitement, at times bordering on hysteria, encouraging impatient demands for progress and tending to lead to hastily considered programs and projects, which if they are not wisely chosen may lead to bitter disappointment and end in general public distrust.

Many experienced observers believe that it is time to inquire critically whether the public interest in cancer is intelligent and is being directed along sound lines or whether it is largely emotional and uncritical, whether the resources that are being poured into this field with increasing liberality are well controlled or largely wasted, and whether the medical profession is wisely organized for its work, or comparatively disorganized as some critics assert, and whether the present state of knowledge of cancer and of the sciences on which that knowledge depends justifies the large hopes and urgent demands for sensational progress which the public are now indulging.

The general public, a large proportion of the medical profession and some scientific men believe that cancer is a single disease like syphilis or tuberculosis, and that its control involves much the same methods. What the public wants is a cure for disseminated cancer and it is assumed that this cure will follow the discovery of the so-called "cause of cancer." These notions are erroneous. Cancer is not a single disease, but a great group of diseases dependent on a universal property of animal cells. The causes of malignant growth include all the classes of forces known in nature, and the malignant growth process in cancer is as obscure as the nature of growth itself. Even if the nature of the cancer process were fully explained, there is no assurance that such knowledge would place us in control of the process. General pathologists will hesitate to concede that a disease which has spread over many organs and systems of the body, producing serious structural changes, can be arrested and the body restored to a serviceable condition even if life be prolonged. Thus the main bases of the public hopes about cancer are unsubstantial or false, and until they are replaced with sounder ideas, the public will mislead itself.

Many serious missteps in the history of cancer and in its present situation are traceable to the above misconceptions on the part of the public. In America and elsewhere in the past and at the present time very liberal support to cancer projects has come from men of large means, who have resolved to strike directly at the cause and cure of cancer. These worthy philanthropists fall into several classes. One class has listened to the fervid tales of pseudo scientific adventurers or outright imposters, who begin by decrying the methods of orthodox medicine, overemphasizing so-called medical intolerance, asserting their own scientific knowledge and vision, and displaying a plan of procedure which to the uninitiated benefactor seems plausible, and thus securing ever-increasing confidence and support as misinterpreted reports of alleged partial successes begin to be gathered. It is not necessary to accuse either party of frank dishonesty. The benefactor knows nothing about medicine and the pseudo-scientist knows nothing about cancer, and both cordially deceive the other. Certain well-known projects of this class have grown to enormous proportions, involving the expenditure of millions of dollars, deceiving thousands of patients, surviving repeated public exposures, migrating from one misused territory to other virgin soils, but often gaining steadily in support from a small proportion of misguided souls in and out of medicine and reputable society. One of the chief sources of active support comes from a class of the socially elect, who perceive an opportunity of helping the persecuted scientist and possibly acquiring notoriety from the expected connection with a sensational piece of news when the new remedy finally triumphs. In one instance the "scientist," after escaping from the officers of the law down a fire escape in his pajamas, shortly appears at fashionable tea parties in Florida, later establishes quarters in New York, moves to London with less success, but gains a footing in a European laboratory. In another instance the scientist, after surviving several devastating exposures, finally lands in one of the most prominent laboratories of this country, where it requires two years before his stealthy methods and utter incompetence are demonstrated. Inquiring into the psychology of the benefactors of this class it appears that the gambling spirit is the basic motive, but only complete ignorance of the popular sort permits this motive to persist over so many disillusions. In certain other cases the benefactor was said by his friends to be mentally unsound. In all cases the fuel on which this fire feeds is the despair of the advanced cancer victim.

Another group of philanthropists are animated by the desire to find a cure for cancer and give liberal or even elaborate support to projects conceived and directed by unattached physicians, who are honest and orthodox but who have little or no knowledge of cancer. The benefactors are generally men of high intelligence but poor sagacity. The number of such projects now in existence is considerable, and the amount of money involved reaches a large total. Newspaper publicity marks the initiation of such projects, attracts for a time a large number of patients and continues to serve as an abnormal stimulus, although repudiated by the parties concerned. The methods employed are loosely ethical and a certain amount of scientific talent may be involved, but publications tend to be limited to the semi-medical press or to private communications. The promoters do not venture to present their work to their medical peers. The life of such projects is often rather tenacious and depends on the degree of isolation of the promoter and the patience and loyalty of the benefactor. This class of semi-scientific cancer cures forms a most disturbing chapter in cancer research in this and other countries. It diverts much money from reliable projects, deludes thousands of cancer victims and encourages the public appetite for sensational discoveries. The public should recall that men do not gather figs from thistles, and that no first-class medical discovery ever came from uninstructed persons.

Finally the determination to go after the cause and cure of cancer has been the impelling motive in the creation of some of the most important bequests now available in cancer research, and the feeling that sensational discoveries are imminent dominates the activities of some of the highest official scientific or-

ganizations. Thus the worthy donor of one of the largest gifts hopes, by greatly increasing the number of workers, to hit by chance the fortunate lead. Another donor urges the immediate investigation of the more appealing cancer cures announced in the newspapers. The sane and sagacious director of another outstanding organization was recently replaced by the appointment of a more modern, less informed, but more popular and more imaginative investigator, whose record includes the most brilliant fiasco in the history of modern cancer research.

I have referred in some detail to these various current sources of support of cancer research because they seem to reflect the prevailing attitude of the American public toward the cancer problem. They reveal that the popular approach to this great subject is highly emotional, which perhaps is not to be deprecated, but at the same time it is gravely lacking in intelligent comprehension of the nature of the problem, of the results which may reasonably be expected to come from laboratory research and of the methods which must be adopted, if real progress is to be secured. It is clear that large resources are being ineffectively employed, or futilely dissipated in the pursuit of topics which belong essentially in the pure sciences and have no connection with cancer. Well-meaning philanthropists must be warned that the odds are overwhelmingly against any one who listens to the fervid tales of great discoveries and undertakes to support the projects of visionary pseudo-scientists who know nothing about cancer and have no standing in the cancer world. The emotional parlor socialist who champions the supposed neglected and persecuted cancer genius is a pernicious influence in society. Even the more carefully considered schemes which involve the distribution of grants-in-aid, small sums from large foundations given for short periods over a very wide field, have demonstrated their limitations, and in fact have created conditions which in the experience of accredited directors of cancer research are almost intolerable. This system calls for an undignified resort to salesmanship by the directors of research laboratories who are compelled to support their claims for aid by promising rather more than they can expect to accomplish. The system attracts to the cancer field a great number of uninstructed workers who accomplish nothing of importance, but become a burden to the system. The opportunity of establishing careers for competent men who may possibly produce results of value once every five or ten years is excluded. The real problems of cancer are not to be elucidated by transient sporadic exploits of men mainly interested in other subjects. The outstanding contributors in cancer have all been men who enjoyed a broad foundation and who labored steadfastly for many years on competently conceived and skilfully conducted investigations. The system of grants-in-aid has been of substantial value in some other fields, but in cancer research its record has been mainly one of alleviating the working conditions in many laboratories, and in maintaining the general level of activity, but it has produced nothing of outstanding value. Accordingly it is the considered opinion of the directors of the established cancer laboratories in Europe and America that the system is to be disapproved and should be reorganized.

Disappointed by the paucity of results from cancer research and impressed by the sensational advances in industrial research and sharing the popular misconceptions of the nature of cancer problems, some critics, and especially the science editors, have asserted that modern cancer research is not well organized, that the workers do not cooperate, that secrecy and jealousy prevail in its ranks, that duplication of effort exists, that investigations are not broadly and competently designed, and that if the methods of industrial research were adopted, the problems of cancer would shortly be revealed as comparatively simple like those in the industrial field and in the simple sciences. One enthusiastic editor has declared that if he had a million dollars and the support of leaders in the industrial field he would solve the problem of the secret of cancer in five years. These assertions must be vigorously rejected. There is no better organized department of human endeavor than modern cancer research under the conditions provided. The whole cancer world is promptly informed of every new development in any part of the scientific world, by means of a comprehensive literature and very numerous local and international congresses and constant interchange of workers. The most friendly relations exist. There is need of repetition and more repetition of all new contributions in the biological field, for the genius of biological processes is infinite variation. It is evident that the science editors do not comprehend cancer problems and are not familiar with the history of the knowledge of cancer nor of the revolutionary progress that has been made in the past thirty-five years.

Nevertheless, the science editors are correct in suspecting that cancer research is not broadly organized and that if the conditions existing in industrial research were introduced, much greater progress would result. The resources available in industrial research are incomparably greater than in cancer. The steel industries of America alone spend $10,000,000 annually in research. This sum is little less than the total capital invested in cancer research in America. It is wholly beyond the capacity of any cancer laboratory to plan investigations on the scope and with the liberality enjoyed by industrial organizations. One of the chief

reasons is the fact that the main sources of support for cancer, outside of certain few institutions whose resources are now fully occupied in many directions, comes from foundations giving small grants in aid of small projects for short periods. This is the very antithesis of the policy of industrial research, which provides unlimited sums for extended periods for highly trained workers who are permanently assured of their positions. The conditions existing in industrial research should be introduced into cancer research.

Even then there is little comprehension of the great complexity and vast scope of the many solvable problems in the cancer field and of the probably insolvable nature of the main problem of the secret of malignant growth. Consider the scope of the program required if a really comprehensive investigation of such a disease group as lymphosarcoma were undertaken. This is a comparatively frequent, very fatal, local or general disease of the lymphatic system. It is probably of infectious origin and essentially inflammatory nature, but often exhibits neoplastic properties, because of which it is classed with cancer. Its sub-varieties vary widely, some being acute and febrile, others prolonged, but nearly always fatal. Regarding its causation, essential nature and fundamental properties practically nothing is known, diagnosis is difficult and treatment is ineffective. No systematic investigation of this disease is being conducted anywhere. An adequate attack on the problem of lymphosarcoma would require an organization coordinating many of the medical sciences, as epidemiology, pathological anatomy, experimental pathology, clinical medicine, bacteriology, serology, immunology, endocrinology and roentgenology, and the work could be conducted only in a large general or special institution where there is abundant material, an adequate well-trained staff and aid from the pure sciences. An income of about $50,000.00 a year for an indefinite period would be required to finance such a project, or a capital of $1,500,000.00.

Yet there are serious difficulties in the path of such an undertaking. It would be difficult to find competent men willing to confine themselves mainly to a narrow field in which results might be few and far between. Syndicated research in medicine has not been very profitable. The careers and psychology of the workers must be considered. Promising side lines might well develop in the course of the investigation and draw the worker into other fields. Essential knowledge might come, not from the direct attack, but from some wholly unexpected source. Substantial salaries would be required to hold highly competent investigators. Nevertheless, from such an undertaking one could reasonably promise substantial additions to knowledge, improvements in methods of diagnosis and treatment, probably certain means of prophylaxis and a general elucidation of the whole problem not now possible from the present type of isolated and sporadic efforts. It would bring one department of cancer research more in line with industrial research. In my opinion it is worth a trial.

There are scores of other diseases in the cancer field, each with its own problems which would require the same elaborate treatment, if the methods of industrial research are introduced. The scope of such an undertaking seems to have wholly escaped our critics. If society is determined that there must be more progress in the medical control of malignant neoplastic disease, it must be prepared to embark on a program of material support and scientific organization vastly broader than has yet entered the minds of philanthropists, government officials and most workers in the cancer field.

We come now to consider the position of the modern cancer research institute devoted to investigation of the fundamental problems of cancer. Of these there are one or more in nearly every large country, but the total number is not large. They represent medicine's best effort and carry its main hope for a solution of the so-called cancer problem, including the ultimate nature of malignant growth and a cure for disseminated cancer. During the past forty years these laboratories have been the main source of a great body of knowledge, including the transplantability of lower animal tumors, the existence of a form of immunity to cancer, the influence of heredity, the peculiar fermentative metabolism of most cancer tissue (Warburg), the influence of embryonal cell extracts on growth (Spemann), the influence of vitamins and other growth-stimulating agents, the existence of peculiar neoplastic diseases of fowl transmissible by cell-free viruses (Rous), the part played by hormones in the inception of tumors, the experimental production of tumors by a great variety of agents and the existence of highly potent cancerigenic chemicals. This great body of new knowledge has for the first time in history cleared away much of the mystery of the process and permitted a rather comprehensive and satisfying conception of the general significance of malignant growth in the animal kingdom. It has led steadily to the conclusion that the forces responsible for malignant growth are inherent in the cell and that the problem of cancer is essentially the same as that of normal growth.

What fundamental cancer research has not accomplished is to provide knowledge of practical value to the cancer patient, to furnish a cure for disseminated cancer or even to extend the control of cancer in the human being. It is extremely disappointing to those who have witnessed this modern era of fundamental research to have to acknowledge the paucity of prac-

tical results for the human being suffering from cancer. Yet during this same period there have been revolutionary advances in the diagnosis and treatment of cancer which have vastly improved the outlook for the cancer patient. These advances have come from the labors of a great number of pathologists, physicians, surgeons, radiologists and technicians, who have worked faithfully to meet the flood of solvable problems that arise in the wards of the cancer hospital and which differ in each form of cancer. They have drawn constantly for aid on laboratory research and on the various pure and applied sciences, but in general they have been content to be hewers of wood and drawers of water. The most important source of aid in cancer treatment has undoubtedly come from the discovery of radium and x-rays and the science of radiology, but highly important has been the widened knowledge of the different forms of neoplastic disease and their natural history and complications and the greater specialization and better organization of cancer service. As an example of this progress one may point to the five-year cure rate for tongue cancer, which in the best clinics in the past twenty-five years has risen from 10 per cent. to 26 per cent. of all comers. Even more significant has been the elimination of several dangerous and ineffective operations in favor of radiation, which is comparatively free from morbidity and mortality. The importance of radiation as a palliative for advanced cancer can hardly be overestimated. It is not too much to say that radiation treatment of cancer is the outstanding contribution of medicine to humanity in the present century and outweighs all previous progress in this field.

The significance of this contrast between the results obtained by the two main branches of cancer research may not wisely be ignored by those in charge of the resources now being made available in increasing measure for cancer control. There is every reason to believe that history will repeat itself and that the record of the past forty years will be duplicated in the next forty years. If so, then it is unwise to multiply isolated fundamental research institutions dissociated from human contacts and the sound direction of clinical medicine, and manned by workers who have little knowledge of cancer. Otherwise we may be reminded in increasing degree of Lord Chesterton's reflection that "science is the noblest of the toys by which we maintain the youth of the race." Also it will prove unwise to multiply independent cancer research foundations, distributing small grants to a multitude of miscellaneous workers mainly interested in biology and chemistry, but impelled by financial opportunity to take an occasional glance at cancer. Otherwise we shall be reminded of another reflection of Lord Chesterton, who remarked that, "Much research reminds one of a blind man looking in a dark room for a black hat that is not there." Moreover, there is urgent need for much greater support and concentration of effort in the great number of existing cancer institutes and highly competent clinical organizations which are operated by men deeply immersed in all phases of the cancer problem, who are keenly alive to the opportunities for important fundamental progress and who in the past have contributed the great bulk of the new knowledge which has been transferred immediately to human needs. No one would question the necessity of abundant support of the fundamental investigations which have so brilliantly illuminated the theoretical problems of cancer. All that one can properly demand is a clear understanding of the real significance of the two branches of research and a wise balancing of resources between them. A first step in this direction is to rob fundamental cancer research of the glamor it enjoys in the public mind and to point out the source from which the public may expect relief from the ravages of cancer.

Having given a rather conservative estimate of the prospects of fundamenal cancer research, it is permissible to indulge one's imagination and offer a more optimistic picture of what may possibly be accomplished in the future. Chemotherapy has occupied a great many investigators for many years past, who have hoped to find a chemical agent which could injure or destroy cancer cells without killing the patient. The heavy metals, especially, have been chiefly used, but the results are practically negative, because no heavy metal possesses any special affinity to unite with cancer tissue which is nearly homogeneous with the normal tissues. The sensational effects of sulfanilamide on streptococcus infection and of arsenic in syphilis naturally arouse hopes that some such specific agent might be found for cancer, but both the syphilis organism and the streptococcus are alien to the body, and the cancer cell is not. It is difficult to find any reasonable basis for the hope that the direct chemical attack of the cancer cell will prove successful. Yet the numerous studies of the relation between molecular structure and physiological action are being extended over a wide field and may possibly bring to light some agent antagonistic to certain types of cancer tissue. An indirect chemical approach, however, appears to be much more reasonable. We now know that the growth of cancer is often dependent on the action of growth-stimulating substances, which are not themselves the nutritive molecule but enable the cell to appropriate the nutritive substance. In 1905 Ehrlich announced this doctrine of athrepsia, designating the growth stimulant as the X substance, but his optimistic prophecy of an early solution of the cancer problem based on this theory was not realized. The field of

growth-stimulating agents is now widening and includes vitamins, hormones and tissue cell extracts of undetermined nature. It may be possible to find chemical antagonists to these agents and thus indirectly limit the growth of some cancers. The most striking examples of spontaneous regression of disseminated cancer have been observed when such growth stimulants have been withdrawn from the body.

Chemical studies of cancer metabolism have carried us deeply into the secrets of the malignant growth process, and chemistry constantly threatens to resolve the whole mystery. When Warburg announced his discovery that cancer cells have lost the capacity to appropriate oxygen and obtain energy mainly by a fermentative metabolism with the production of great quantities of lactic acid it was hoped that the secret of malignant growth was about to be revealed. It was supposed that the cancer cell can survive without oxygen, but this is far from the fact, for cancer tissue is extremely vulnerable to lack of oxygen and suffers bulky necrosis from a slight reduction in blood supply. Efforts to supply oxygen or peroxidases artificially have been attempted on an elaborate scale in many countries, but without effect other than the peculiar intoxication of oxygen. The respiratory mechanism of the cancer cell is injured and it can not appropriate oxygen which is generally present in cancer tissue in normal or increased amount. All efforts to destroy the cancer cell by disturbing its peculiar metabolism have failed and seem likely to fail. Moreover, all malignant tumor processes do not exhibit this type of metabolism. It is said that Warburg has given up the study of cancer entirely and will devote himself for the next ten years to the question of cell respiration.

Physical chemistry has made many approaches to the cancer problem, but has failed to leave any definite impression on it. It has discussed the osmotic relations which permit the cell to absorb enormous quantities of nutriment, the influence of surface tension, and recently the subject of surface films. It has recorded the interesting electric phenomena which transpire in mitotic cells and growing cancer tissue, and it has contributed the intangible doctrine of mitogenic radiation. Its exponents are hopeful that this fascinating science may in time attract serious consideration as a method of elucidating the secrets of the biological process of malignant growth. The bioelectric theory of growth of Burr and Northrop has recently been applied to the study of mammary cancer of mice with interesting theoretical results. No doubt there are innumerable phenomena connected with the cancer process and yet to be recorded.

Spemann's discovery of embryogenic organizers and inducers has revealed a new class of growth-controlling cell products which may have an important bearing on the cancer problem. He found that extracts of embryonal cells, as of the neural crest, possess the capacity of inducing other indifferent tissue cells to produce neural tissue when injected into other portions of the embryo. These extracts not only stimulate growth, but determine its character, but they do not produce malignant growth. There are many phenomena in cancer which suggest the action of cell derivatives, which maintain and determine the character of the growth and which have not yet been isolated or identified. Murphy and his co-workers have made essential contributions in this field and determined many of the properties of these growth-stimulating and inhibiting cell extracts. In the group of fowl sarcomas cell extracts assume the property of active cancerigenic agents.

The parasitic theory of cancer has always adjusted itself to the current knowledge of microbiology, and to-day it takes the form of the virus theory, that cancer is a general disease caused by a filterable propagable microorganism. This theory is held by some eminent investigators whose views are based mainly on the fact that the fowl sarcomas are transmissible by a cell-free filterable agent. The exact nature of this virus is not yet fully determined, but the weight of evidence is in favor of the view that it is a chemical agent. The infectious nature of common warts has long been known and recently Shope found that the papilloma of the skin of wild rabbits is transmissible to other rabbits through a cell-free filtrate. Rous then found that this agent produces in domestic rabbits much more active growth of warts and that some of these after becoming fissured and ulcerated lead to a low-grade carcinoma. He then combined the action of benzpyrene and the rabbit virus, rubbing the chemical into the skin and injecting the virus into the blood stream and found the resulting warts to be far more vigorous than after the action of either agent alone, while many of the warts became malignant. This ingenious experiment suggests that multiple factors may be concerned in the origin of some cancers and that one of these agents may be a virus. This hypothesis deserves further pursuit and may very well result in the inclusion of viruses in the etiology of certain epithelial tumors in man. The infectious behavior of certain papillary tumors of the mucous membranes has long been recognized by clinicians.

The discovery of very active cancerigenic properties in the cyclic compounds derived from coal tar, by Kennaway and Cook, justifies the hope that a substantial number of human cancers may be assigned to this class of agents. Already the number of these cancerigenic chemicals is considerable, and the specific

property seems to extend over a variety of related molecular structures. Moreover, it is shown that many substances normally present in the body are closely related to the coal tar compounds, such as the sterols, bile acids and the sex hormones, and that these may exhibit cancerigenic properties after slight degradation. That such changes in normal animal secretions actually occur in the body is not known, but it is probable that the body possesses mechanisms capable of inducing them. A very wide range of activity of the various hormones and some vitamins in causing cell proliferation and precancerous changes has been established, and it is probable that hormones enter into the etiology of many forms of cancer, especially of the sex organs.

Thus has grown up within a few years an entirely new and a very broad field of investigation of chemical agents, inorganic and organic, as causes of cancer, in which a large part of the cancer world is busily engaged. This field seems sharply contrasted with the virus theory, but if the viruses should prove to be only a peculiar form of cell product, the two fields may eventually converge.

These are some of the many promising topics which now occupy the modern cancer research laboratory engaged in fundamental research into the causes of cancer. Never before has cancer research offered so many alluring leads, and one may reasonably hope that these studies may soon greatly illuminate the etiology of many forms of cancer, provide a basis of prevention, and even lead to the discovery of a specific cure for some varieties of malignant tumors. Yet there is no indication that the newer cancerigenic agents and mechanisms are of universal application. On the contrary they serve rather to sharpen the contrasts between the many different forms of cancer, and they have not yet been of any practical value in the treatment of human cancer. For such eagerly sought results we must look to an entirely different field of investigation.

Indulging now the same imaginative spirit applied to the outlook for fundamental cancer research, what may the optimist expect from the study of cancer in the human subject by the army of clinicians and pathologists? Doubtless the greatest advances are anticipated in the improvements in radiation therapy, by means of the supervoltage x-ray machines, running as high as one and a half to three million volts. With every increase in voltage there has been an improvement in therapeutic results in one form or another and it seems highly probable that this ratio will continue considerably further but not indefinitely. We may rather confidentially expect that some deep-seated and resistant tumors may yield to these newer combinations of voltage and intensity. It is clear that large amounts of artificially radioactive substances can be produced by the cyclotron or the supervoltage x-ray apparatus, but there are practical difficulties in employing these agents for the human patient, and too great hopes should not be indulged in this direction. It has been shown that neutrons have a somewhat more destructive action on tissue cells than radium rays, but whether this form of energy can be harnessed and will give more selective effects on tumor cells is quite uncertain. However, physical agents have been shown to have such remarkable power to control the growth of cancer that no one would place sharp limitations to their future scope. The search for adjuvants to radiant energy, physical and chemical, offers an important field of investigation. Finally, the numerous minor improvements in the use of present available agents and apparatus, such as the divided dose technique, and the limitation of size of portals have greatly advanced therapeutic results, and similar advances will doubtless continue without any major contribution from physics.

Of the highest importance are the observations being made constantly by clinicians and pathologists on the exciting factors, clinical varieties, course and complications and methods of prevention of the various forms of cancer in the human subject. It is the function of clinical medicine to find the solvable problems and turn them over to the proper experts for solution, and in no field is this relation more intimate than in cancer. For this reason cancer research progresses more rapidly when conducted under the stimulus and direction of the flood of problems arising in a cancer hospital. Under these circumstances the standard of service, the education of the physician and the results of treatment are maintained at the highest level and make progress. Hence we find that in the past thirty-five years the outlook for the cancer patient has been enormously improved, and in the future we may expect that the better organization of cancer service, the building of cancer hospitals and the specialization of cancer clinics in general hospitals, without any sensational announcements, will produce a steady advance in the cure rate. In these activities lies the sole personal interest of the present generation of the public in the cancer problem, and not in the vaguer realm of fundamental research.

From the foregoing review certain general conclusions may be drawn. The American public has acquired a lively interest in the whole subject of cancer control and this interest, if wisely controlled and directed, is capable of bringing results of the highest importance. It is evident that public opinion has largely determined the organization of cancer research and control in this country, but that available resources have been greatly dissipated because of mis-

conceptions and false hopes on the part of the public. It is therefore essential that public education regarding the general facts of cancer and the probable sources of relief from this disease be developed to the highest degree. Every American citizen should become acquainted with the main facts about cancer and especially with the early signs of its major forms. He should indulge in periodic examinations by a competent physician, running down suspicious signs, detecting and discarding cancer-forming habits and removing precancerous lesions. He should inquire into his personal hereditary tendencies, which occasionally yield valuable clues. For these ends he should join his local branch of the Cancer Control Society or the National Society, attend public discussions of this subject and lend his support to the whole movement. The little Danish Cancer Society has ten times as many members as the American.

If he is a physician, he should be cancer conscious and alert to detect the early signs of the disease in his patients, taking nothing for granted. He should maintain his education by constant reading, faithful attendance at meetings, and should cultivate a progressive attitude toward modern organization of service and methods of treatment. In the treatment of cancer he should employ his talents, but recognize his limitations and the necessity of special skill in special fields.

If he is a philanthropist, he will be exceedingly cautious about trusting his judgment as a layman in the support of individual cancer projects. If he is a man of large means and large ideas, he will not prefer to play a lone hand, but will throw his resources in with others in one of the established institutions devoted to service or research. The trustees of Cancer Foundations will continue their invaluable support of cancer research on a broad scale, but may do well to consider some of the constructive suggestions made for the purpose of making their services more effective.

As public health agencies become more identified with cancer control it seems very necessary that the work of municipal, state and federal groups should be carefully coordinated with each other and with voluntary hospitals. The states should proceed cautiously before committing themselves to an expensive program of building hospitals for the exclusive care of advanced and indigent cases. It is probably far better to rely upon the resources of the organized medical profession and develop facilities for adequate diagnosis and treatment of early cases in as many localities as necessary. Otherwise there will always be a superabundance of advanced cases. The Federal Government would do well to study carefully the experience of other nations in the support of cancer research and service, and not commit itself to an irreversible program, defects of which may become obvious only after years of misdirected efforts and expense. There are many who believe that the search for the cause and cure of cancer is far removed from any function or responsibility of government. Yet there are many formidable research projects and immediate practical needs for which the large resources of the federal treasury seem to be the only resort.

When all the forces centering on cancer control are well coordinated and effective, relief from cancer will still remain essentially a problem for the individual man or woman. Alertness of the individual in avoiding cancer-forming habits, in detecting the premonitory signs of the disease and in accepting adequate treatment as early as possible will always remain the only effective protection. Habits of moderation in eating and living and the cultivation of a certain fastidiousness about one's person are wise resolves if one wishes to avoid cancer. This philosophy is quite appropriate for the modern man, woman and child, for there is every indication that cancer will long continue the most frequent, the most lethal and paradoxically the most curable major cause of death.

SCIENTIFIC EVENTS

THE TRING ZOOLOGICAL MUSEUM

LORD ROTHSCHILD, who bequeathed his zoological museum to the British Museum, made the provision that the legacy be accepted as an annex of the museum to be used in a modified form for zoological research. A correspondent of the London *Times* gives the following description of the museum. The building stands on a freehold site of some three acres on the outskirts of the town of Tring, close to Tring Park. It began in 1889 with a cottage in which Lord Rothschild housed his insect collection, and now consists of a main building forming three sides of a square and a large annex. These buildings occupy more than half an acre, and the aggregate floor space is about an acre and a half.

The museum, on which Lord Rothschild is believed to have spent more than £500,000, contains a zoological collection, a library (chiefly zoological, and especially entomological, but also to some extent botanical) of 30,000 volumes, and many original paintings of mammals and birds. The establishment consists of exhibition galleries which have been open to the public, the average yearly attendance being about 15,000 and of a research section which has, as a rule, been available to students only.

In the public galleries the exhibits include some 2,000