Medicine and the Bicentennial

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I am indeed honored to be asked to contribute to the Harris County Medical Society Bulletin on a Bicentennial view of medicine. Over the past two years I have been asked my views about medicine in the next two hundred years and even the next two thousand years by various news magazines and commentators. If we are to look back at this point in our history at the past two hundred years one would certainly be impressed with the progress made in the last hundred or indeed in the last fifty years compared to any previous time period. Medical history has well recorded most of the progress made in the various medical fields and certainly the greatest single advance has been in the control of infectious diseases. Indeed with the use of antibiotics, vaccines and environmental control some of these diseases have become almost non-existent.

I do not intend to try to reconstruct a medical history. There are many noted experts around, certainly so here in our own medical center in Houston, who are the proper persons to address advances in their particular fields whether it be cancer, heart disease, etc. I do want to direct my thoughts to a milestone in medical history with which I was particularly associated and then try and look ahead at the next two hundred years. I would like to present my viewpoint as a physician privileged to have pioneered a new medical area, space medicine, and now, again privileged to apply that knowledge to medicine here on the earth. If I were to try to characterize my specialty interest in

medicine I should say that preventive medicine is my game. Aerospace medicine is just that - preventive medicine, and certainly community medicine is founded on the same precept. As one looks at the two hundred years of medical progress there have been many brilliant discoveries in technique, and methods of disease control and certainly few would deny that one of the landmarks of progress of mankind was man's safe conduct of his greatest adventure yet - entering space and returning safely. It was my privilege to face the challenge of whether man could do it and to be given the responsibility to prove that he could. In carrying out this responsibility, it soon became evident that to provide for man's safety required a multidisciplinary team plus the involvement of government, industry, universities, and indeed the whole nation working together for a common goal much as it did two hundred years before this Bicentennial as we fought for our independence in 1776. We were not dealing with an illness as such, for we were starting with a healthy man who had to face an alien and little known environment, hopefully adapt to it, readapt on his return to earth and do all this while safely controlling the vehicle which allowed him to escape earth's gravity and return safely to it. The magnitude of the problem we faced was characterized by the fact that a very prestigious scientific committee, headed by a noted professor of medicine from the Academy of Sciences, very nearly prevented the launch of our first manned space flight because of predicted and suspected medical difficulties which might be encountered. Certainly, man's ability to withstand the stresses of entering into and returning from space were unknown. We had some information that was relative from our X-15 pilot monitoring. Of even greater concern to the physicians, physiologists, psychologists, and engineers was the effect of the peculiar environment of weightlessness upon man's body and the ultimate question of whether he would be able to perform as a pilot of a spacecraft as he attempted to adapt to this

peculiar environmental effect, the loss of the gravity, in which he had been born. This concern reached the halls of Congress as well as the Academy of Sciences and other scientific groups and remained a constant challenge and threat as we continued our efforts to get man to the nearest "planet", the moon, and safely return him to earth. This was the task given us by President Kennedy. In Project Mercury from May 1961, the fifteen minute flight of Al Shepard, to May 1963, the thirty-four hour flight of Gordon Cooper, we were able to show that a lone man could indeed survive in this environment and could exert some control of the spacecraft. The first early physiological changes involving the cardiovascular system were noted. This was evidenced by orthostatichypotension in the immediate postflight state. In the concentrated flight program involving two astronauts per spacecraft, Project Gemini flown March 23, 1965 to November 5, 1966, we were able to explore man's physiological response for durations of four, eight, and fourteen days. This allowed us some cautious doubling of our exposure periods and the fourteen days was the longest mission that we anticipated within the Apollo lunar landing series. We also gained experience with docking, which was vital to the lunar missions and also our earliest experience with extra-vehicular activity. We noted a number of changes involving the cardiovascular system, the red and white blood cells, the musculo-skeletal system. None of these changes were of sufficient import inflight to interfere with performance, nor were they of magnitude or duration postflight to cause concern as we looked toward man's capability to reach the moon and return safely. Our biggest questions, as we looked at the future, were whether the changes were going to continue to increase in magnitude with increasing flight durations, whether they would cycle or whether they would plateau.

The Apollo lunar mission series thus was approached with a great deal more assurance from the medical point of view than the previous missions had been due to our experience with Mercury and Gemini. We knew that the flight durations would be no longer than those experienced in Gemini but we also knew that we were asking much of man in his performance in leaving earth orbit, landing on and exploring the lunar surface and returning to the planet Earth. The Apollo series from Apollo 7, September 11, 1968, through Apollo 17, December 7, 1972, was extremely successful. The key milestone in the flight series was man's landing on the moon, July 20, 1969. Our basic medical problem of supporting man in this environment and determining the cost of working on the lunar surface during extra-vehicular activity was complicated by the development of some particular preventive medicine measures in the pre- and postflight periods. In addition, our medical task was further complicated by the necessity to protect the earth's biosphere from the possibility of contamination from a lunar organism returned from the early landings. This necessitated development of an elaborate lunar quarantine operation to assure that neither man, animal, nor plant life would be affected by anything returned with the lunar material. This was successfully accomplished and the principle biological effects noted were some sensitivity to the dust and some increased growth in plants exposed to this material. Apollo 13 added two new dimensions when preflight we were faced with the problem of a crewman exposed to reubella who had no immunity to the disease. This necessitated a crew change at the last minute and this mission subsequently became one of our most difficult as the oxygen tank in the service module exploded and the entire mission became one of balancing man against an extremely difficult environment with limited resources of

oxygen, water, carbon dioxide absorbent, warmth, etc. Apollo 15, launched on July 26, 1971, revealed our first inflight cardiovascular problem when an episode of bigeminal rhythm and a series of premature ventricular contractions with a very slow heart rate were observed in the two crewmen who had been on the lunar surface. In addition, this crew performed contrary to all our previous experience where crews had returned to their preflight physiological baselines within a matter of three days. This crew took twenty-one days to return to their phsyiologic baselines involving exercise capacity and in cardiovascular response to lower body negative pressure. This was certainly an anomaly in our entire flight program and added fuel to a scientific and political question which had been raised from the beginning of the program - was man capable of performing for sustained periods in the weightless environment of space or was he doomed to failure as a result of the effects upon his own physiology and psychology? There were many who thought the latter to be the case. In June of 1969, Bio-satellite III had been launched for a thirty day mission that landed eight days later. The monkey, Bonney, died ten hours after recovery. This animal had been instrumented in a very complete manner to obtain all the data possible on a single animal flight, deep brain probes and catheters, virtually every area, arterial, venous, uretheral, etc., were in place. It was stated by some of the investigators that the animal's death was due to weightlessness and this created a Congressional investigation which occupied a considerable amount of my time following Apollo 11. This was followed closely by the accident of Apollo 13 in April of 1970 lending further ammunition to the doubters. In June of 1970 our Russian colleagues launched and recovered Soyuz 9 after eighteen days of space flight. This crew like that of Apollo 15 which would follow a year later were markedly different from the

crew who had flown fourteen days. They had severe hypotension immediately postflight and were unable to egress from the spacecraft without being carried out. Their postflight recovery period was some twenty-one days in duration and again the ammunition of the doubters increased in quantity. The final addition to the doubters armamentarium was added by the Soyuz 11 - Salyut mission in June 1971. As the crew landed following this twenty-four day stay in the orbital station, Soyuz, they were all found dead in the spacecraft.

We had been busily working toward the launch of Skylab approximately a year later and were planning twenty-eight and fifty-six day missions. Many scientific colleagues in high places and on advisory committees as well as committees of the House and Senate and indeed even at the Presidential level, were concerned about man's capability to undertake such missions. A great deal of patient review of our data and reassurance about our capability to monitor man successfully during the projected Skylab missions finally resulted in a decision to launch the Skylab laboratory on May 14, 1973. Three successful missions were launched between May and November of 1973 with durations of twenty-eight, fifty-nine, and eighty-four days.

In view of the scientific and political environment in which Skylab was flown it is remarkable but not as surprising as one might expect, that the most significant achievement is the accumulation of a large volume of negative data. These data allowed us to reach the conclusion that man is capable of adapting physiologically and psychologically to the Og or weightless environment and that he can change that adaptation after a period as long as 84 days and readapt himself to a normal lg, earth environment. The significance of this finding to the future of man in space is truly monumental. Not only did the crewmen show themselves capable of readapting to lg but they readapted in increasingly shorter periods with increasing flight duration, the opposite of what one might expect. They were able to egress the spacecraft under their own power as most of you probably saw on TV and this was in marked contrast to some of the findings of our Russian colleagues. Happily we continued to be impressed with the marked individual variations shown by human beings in their physiologic and psychologic responses. This is one of the greatest qualities and attributes of humans as all physicians know. It does lead to difficulty in interpretation of data at times but we feel that the data base obtained in Skylab allows the drawing of the above conclusions without question.

All of the crewmen on recovery had a mixture of signs and symptoms relating principally to the cardiovascular, the central nervous, the vestibular and the hematologic systems. There was some loss of muscle mass, even with increasing exercise loads, and there was a continuing and progressively small loss of calcium from the skeleton with increasing flight durations. A

fantastic amount of detailed inflight data were obtained which will be studied for years and which has led us to the development of hypotheses for the mechanisms of these changes.

As we look ahead at future flight programs there are three significant things to consider. Of all of the physiologic changes noted above, certain ones appear to require counter measures for future longer duration flights. The first of these is the loss of calcium. Bedrest studies may add further data here and certainly therapeutic regimens must be developed based on sound data to prevent this continuing loss with increased flight duration. Four of the nine crewmen developed motion sickness which, though self-limiting due to adaptation to the Og environment, is debilitating for periods up to seven days. Methods of training and/or medication must be used to solve this problem. Further detailed study of the etiology is also important to determine whether it is caused by shifting of blood or by changes in the otolith. Finally, all of the detailed data concerning these various systems must be carefully studied and considered as selection criteria for future passengers and crews are developed.

The qualification of man for spaceflight or proving that he can live and work in an unusual and unique environment such as space is a medical event equal, in my opinion, to the advances in cardiac surgery of the past century. It may indeed have greater effect on his future on this planet for he is not confined to earth and the zero growth, doom on this planet, predictions espoused publicly by the report of the Club of Rome are proven false. Our future

may indeed lie in the space colonies envisioned by Jerry O'Neill and man may be given new life in a new artificial "planet" as he can be given a new heart. Houston is indeed an important place in medical history for it has been the center of the development of both of these medical milestones.

Perhaps the greatest legacy of all from Skylab will be the fallout to ground medicine, rather than mainly its contributions, monumental as they were to the future of manned spaceflight. We have had an unusual opportunity to observe adaptation or acclimatization of the human to a very particular stressor, weightlessness, available to us only in space. The study in adaptational physiology and biochemistry has great import in many fields of medicine on the ground. The ability to physiologically dissect the vestibular system in the unique way provided by weightlessness has allowed us to examine our thoughts about the function and dysfunction of this system. The responses of the cardiovascular system involving pressure and volume changes has offered us a unique model to study the possible relationships to hypertension and other cardiac disease. The 15% loss of red blood cell mass noted after the 28-day flight and not progressive with increased flight duration leads us to some intense studies concerning the governing mechanism of red blood cell mass. This can have great implications to hematology and the control of red blood cell production and loss here on earth. The calcium loss, which appears to parellel that seen in bedrest studies in spite of adequate intakes and which must be solved, will lead us toward solutions of the osteoporosis problem suffered by millions here on earth. We must not merely find therapeutic means, but in dealing with osteoporosis, we must find adequate preventive mechanisms, and institute them at an early age.

In looking ahead at the next 200 years of medicine, I think one of the greatest changes which will be noted, is an emphasis on the healthy rather than on the ill. Health is already rapidly being considered a right of every individual and indeed has been so declared. This will become a reality within the next two hundred years and it calls for great attention to the development of preventive medicine. Careful scrutiny of preventive techniques must be made and then must be applied. It has become increasingly obvious that the application of effective preventive medicine tecnhiques for the conditions of greatest import to man's health today will require more action on the part of the individual than by any member of the health team, contrary to our past experience with infectious disease. This means that health education will come into its own in the next century and that great emphasis will be placed on health education of individuals and groups. The problems faced by the health professionals will be clearly understanding that this is not a simple educational process but indeed a complex one and must be carefully done if it is not to be wasteful and ineffective.

The tremendous advances in technology for the use of medicine, many of which were brought about by the needs of the space program, will continue at an ever increasing pace and with more input from the entire health team and basic scientists so that technology can better and more accurately serve the medical needs. It will provide us with better scientific information to assist in diagnosis and in therapy. Data will be more accurate and more detailed. There will be capability to look for substances previously considered unimportant or even unknown in both urine and blood. We will also continue to develop the capability to determine changes in the body's biochemistry and

and hemeostasis by the use of smaller and smaller, even lamdas of blood and the use of breath, saliva, hair and nails for diagnostic purposes. Thus, better diagnosis will be aided by continuing development of noninvasive techniques for looking at, not only parts of the body, but the entire body by various imaging techniques. Ultrasound will continue to develop for use with moving, functioning organs such as the heart and become ever more commonplace. Computers, while they have grown in the last few years in use, will expand dramatically over the next 200 years and to remarkable sophistication. They will be used as aids or memory banks for screening and diagnosis and increasingly used in the analysis of research data.

These developments will not be without problems not the least of which is balancing what the health care system, individuals or even institutions can afford with what technology can offer. I feel that the technological advances will become cheaper in cost but we must always try and determine the cost effectiveness of the use of such technology. We must also learn to analyze and cope with the accuracy produced and not be caught on the thorn of data which may be meaningless in determining the condition of the patient. I think we are capable of doing this and we must develop and enhance this capability as the technology becomes available. Transfer of technology to the medical field has not been as rapid as I would have envisioned 10 years ago but I feel that this transfer will proceed at ever increasing rates over the next 200 years, for it can save time for busy health professionals and immeasurably add to the capabilities of the health care team whose task will grow with our population.

Population growth in the world and the remoteness of some individuals, even in our own country, as well as in some of the less developed parts of the world, will require the development of techniques for remote medicine, for we will never see the time when every hamlet is capable of having a medical team immediately available on site. I am convinced that the use of remote medicine through either fixed or traveling facilities with the help of various members of the health team, the use of TV, analysis of breath sounds, and transmission of same, the transmission of electrocardiograms and x-ray and the capability to converse at a distance through communications and TV with the patient, will produce control centers in large medical centers that can reach huge areas of a state or a country. Thus, specialty consultation can be provided to even the most remote area and good medicine leading to good health can be made available. This is within the realm of our technology today. We pioneered it in the space program and it is now being pioneered in pilot programs here on earth.

It is evident that if we are to make medicine or health available to the large numbers of people in the world we must work at redefining the roles of people who will be members of the growing health team. As physicians we will learn to work with and utilize these teams and be instrumental in the redefinition of roles to reduce strife and friction. There has already been evident of a need for someone, usually the physician, to assume a key role in being concerned about the individual patient in totality and helping him to determine the care he needs and then to follow him through the maze and help to interpret the information he receives from the various information providers in the health care system. It should be the physician who is

rendering primary care to the individual but we may have to assign someone who works with these various physicians as a medical "broker" and follows the patient to a secure end result directly related to that individual. In this definition of roles we must also be aware that there is much that occurs to patients which we can do nothing about or occasionally even little to alter. As we admit this, we must do all in our power to obtain any type of real help for this patient through the use of other members on the health team.

While basic research is being daily attacked, as is science and technology today, I expect to see the pendulum swing, for I feel that research is essential to medical progress. It is obviously vital to provide immediate care for the patient but that can best be done only if we know the cause of a particular illness or defect and can hopefully develop preventive measures which can be invoked at an early period in life. Basic research offers us the capability for such control and prevention and will continue to be out front at the cutting edge of the development of science and technology in our society. It must provide the tools for the health team to more competently accomplish their task.

Being now in a Health Science Center or Health University setting, I find myself interfacing with an exciting group of members of the health care team, health educators and researchers. Medicine is under severe challenge today and this challenge, I predict, will become no less but indeed more severe with the next hundred years. I sincerely hope and predict that medicine and all those engaged in health care will develop a team organization to

meet the severe challenges to the current views and practices of care. We must not merely maintain the old because it is there but be willing to answer the challenges and to review our practices. This must be done, however, by knowledgeable people who are engaged in the professions in the health field, rather than by political decision makers.

With all the science and technology available, information from research on causation, new diagnostic and treatment methods, certainly much of benefit to the patient can accrue before our tri-or quadcentennial. It is most important however, to realize that perhaps more important than all of these predicted developments is a re-emphasis on humanism. A continuing realization that the patient is a person with particular individual needs, who wants love and consideration as a human being is vital. The treatment, however scientifically based, and accurately administered, will fail if we fail to recognize and respond to these humanistic needs. This requires great awareness and concern on the part of all members of the health team and I am convinced that we are capable of utilizing the time given by the use of technology to administer to the human needs and thus never have patients trying to converse with machines or laboratories but only with physicians and others on the health care team. This again emphasizes that we will be in a time period when it may be more important to properly train a health educator than to train a surgeon to treat the end result of a preventive medicine failure. The advances before our next tri-centennial will be awesome and marvelous indeed but will be to little avail if we do not heed the humanistic needs of those we serve.