CHAPTER FOURTEEN

HEALTH FROM SPACE-CHANGES IN OUR LIVES

Many persons reading this book may do so for the vicarious sensations of travel in space which they may obtain. Indeed, many of you may some day be able to travel to nearby planets, or to earth orbital stations. Most of you, however, will live your entire lives on our planet earth. In this case, the medical findings while having obvious implications to man's future activities in the space environment will certainly be interesting, but of little personal import. One of the most frequently asked questions today is "will any benefit accrue to earthbound man as a result of our efforts to explore the space frontier?" The development of space technology, allowing man to begin the most challenging of all exploration, that of the universe, has produced benefits in many parts of his earthbound life.

Prior to the national commitment to land man on the moon and return him safely, the only event which had produced a rather broad advance in this nation's science and technology was World War II. I am personally convinced that the dominant influence in the explosive expansion of science and resulting technology in the 1960's was the United States Space Program. The task required research on many fronts at the same time, and one of these key areas was medicine and the life sciences. The magnitude of the task thus required advance on the frontier of virtually every scientific and technological discipline in order to conquer the new frontier of space. This gave the country a science and technology base from which to solve many unrelated problems, for the lunar landing timetable compressed these advances into the shortest period yet seen by man. Some of our citizens today cry out that technology and science have created many of our environmental and pollution problems, but it is high time they soberly reflected that we can only solve these problems by drawing on that broad base of scientific and technologic expertise so expanded in the 1960's. We thus stand on the threshold of a new world where such advances can occur without the stimulus, stigma, and devastation of war. The challenge is ours and I say we must take it.

Peace and Understanding: Peace and understanding between peoples of the world has long been the dream of mankind. Each of us would certainly affirm that peace would be a great benefit to health. In my travels in our own country and abroad I have found a groundswell of feeling that our efforts in exploring space will bring us closer together as inhabitants of spaceship earth, regardless of nationality. Following the initial lunar landing, Apollo XI, my wife and I were invited to the Soviet Union by the USSR Academy of Sciences. Through the years I had had many contacts with my Soviet aerospace medicine colleagues at International meetings. Therefore I could not help but have some concern about what their attitude would be toward our having accomplished the lunar landing first, and having done it "for all mankind". They certainly would have preferred to do it "for mankind" themselves. I so strongly believed that this step was for all men everywhere on spaceship earth that I was relieved and delighted by the response of all the Soviets we talked with in our two weeks. There was an immediate feeling of warmth and friendship in every action, and it was voiced in repeated congratulations to the Apollo team. A particularly rememberable event occurred while I was addressing an overflow audience of academicians of the Soviet Academy of Science at the House of Scientists in Moscow. I used a film made of silent film clips of medical activities necessary to make Apollo XI possible and talked about each through an interpreter. The sequences followed the preflight, flight, and postflight activities, and as Neil Armstrong was stepping down on the lunar surface in the lunar module film clip, the entire audience arose, stamped their feet, clapped their hands, and cheered. I could not hold back the tears at this expression of friendship. It was a feeling expressed also by scientists from Moscow to Leningrad to Tbilisi, by workers in vineyards and picnicers in the Caucaus woodlands. As we folkdanced with these heretofore strangers they demonstrated by hugs, and voiced through the interpreter their conviction that the landing of man on the moon was going to bring us closer together on earth. Nor was this limited to Russia, for it has been repeated personally to us in England, Belgium, Netherlands, Spain, Italy, France, Portugal, Germany, Israel, Argentina, and at many International meetings where I have been privileged to represent the space program. We are closer together and have common opportunity to look out from our spaceship earth at the universe, and to go forward exploring it in peace.

On January 21, 1971, the United States and the Soviet Union signed an agreement to exchange information in several areas of space activity. In order to accomplish this exchange , joint working groups were established in the fields of Space Meteorology (Sattelites); Space Meteorology (Rockets); Near-Earth-Space; Planetary; Lunar; Natural Environment; Space Biology and Medicine. I was fortunate to be appointed U.S. Chairman of the Working Group in Space Biology and Medicine. We met in Moscow in October, 1971, and in Houston in May, 1972. A spirit of cooperation and a desire to understand each others problems has been evident in all the sessions. We have each been able to explore details of the Soyuz, Salyut and Apollo Missions which might not be commonly reported in scientific papers as they may represent only a single finding or event. Their importance is great, however, as we review information on the few men (U.S. or U.S.S.R.) who have been in space and then plan for future flights. We are currently working to agree upon some common pre-and post flight examination procedures in order to compare our data better and thus enlarge the data base on man whenever either country has a flight. Our cooperative efforts were further advanced by the agreement signed by President Nixon and Soviet Chairman Kosygin on May 24, 1972. We are now embarked on a new effort, a joint flight mission involving Soyuz and Apollo spacecraft docking and exchanging crews for portions of the mission. In this new era we will sail the sea of space not only in ships whose launches are coordinated, but we will sail it docked together. Here indeed is a large step toward exploring our universe together and thus contributing to peace on earth.

Satellite Benefits

In this chapter I will only attempt to summarize, and in some cases expand upon those benefits of importance to our health on earth, many of which have been briefly noted in previous chapters. Much has been said about the development of unmanned satellites, and the obvious benefits resulting therefrom. Recently the values of communications satellites were forcebly brought home to many people in the world as they were able to view the events of President Nixon's visit to China as they occurred, even though they were happening halfway around the world. These events cannot help but have a profound effect on our lives, and certainly they will also affect health, because they will change our outlook upon life. In addition to communication satellites, there are satellites dedicated to obtain weather information which is well shared throughout the world. The use of this weather information to anticipate the presence of hurricanes and other adverse weather phenomena can certainly benefit health, for such knowledge can prevent the injuries which a hurricane may inflict, as well as much of the disease which could occur following the disruption of normal services in an affected community. One of the continuing dilemmas of the world health planners is the apparent conflict in goals created as we take action to reduce the effects of disease on a population and thus perhaps create an increase in population with its potential for adverse effect on overall health. Medical and public health procedures attempted without understanding on the part of those involved are valueless and doomed to failure. On a recent panel I was asked if I was proposing distribution of "the pill" (birth control medication) by satellite. Obviously this isn't possible, but satellites can be used in the health education field and thus contribute to birth control by allowing information to be beamed to all the remote villages of a country like India. Such efforts should be planned.

In the field of space medicine alone, the requirement to assure man's safety on the journey to, within, and from space, has resulted in much hardware and many techniques of great value to man on the surface of the earth. While these developments were especially for the particular purpose of allowing man to explore on the space frontier, they may also be utilized in rendering preventive, diagnostic and therapeutic medical care on earth. In this sense we can all obtain some "health from space", and our lives may all be changed thereby. The applications of some of the hardware and techniques may be seen most clearly if we review the original requirements for the protection of man in space, and then outline the resulting benefits.

Selection: The initial requirement is the selection of a crew capable of performing the mission required without undue physiologic or psychologic effect. The assessment of the ability of the individual to withstand psychological stress by means of his basic personality defense mechanisisms is an important part of any such selection process. During the ten to sixteen hours of psychiatric and psychological testing and evaluation previously described, a great deal was learned about the capability of these individuals to handle the stresses expected to be encountered in manned space flight. Motivation was a strong factor in all of the applicants tested. The importance of determining the basis for the motivation has been previously described, for obviously it can have a self serving basis as well as that of more desirable origin. Motivation has been utilized by our crewmen to overcome many annoyances of the space flight environment, both preflight, inflight, and post flight, and has been a postive influence on performance and adaptation to the space flight environment. It has been dramatically shown again that the human "machine", the body, is enormously capable of taking punishment in the form of physical and mental stress if the individual is motivated to do so. Humans are also enormously capable of adapting psychologically and physiologically to new and demanding environments. Motivation was most dramatically demonstrated in one of our civilian candidates, who, though he knew of a malignant growth which had been treated, suppressed this information in an attempt to prove his fitness for flight. Obviously, information concerning motivation has come from many ground based experiences also, but the wide visability of the effect of this factor on human performance afforded by the space program is rather unique. In the same vein, the calm and effective handling of anxiety during the pre-launch, launch, and even during in-flight emergency, has proven to be an example desirous of attainment by many in the world, again due to the wide visability afforded these actions of our crews. Hero images have emerged and the world needs such heroes. It is extremely important to realize that while these are highly selected individuals who have become heroes, they are not supermen in any sense of the word. They are very normal human beings who have well adjusted personalities, are achievers, and are physiologically in excellent shape, but they still are subject to the same emotional and physiological ills as the rest of us.

They are excellent examples of the fact that preventive medicine does pay off to the individual in the form of health. The handling of the high motivational level of astronaut applicants also revealed the usefulness of another technique for evaluations involving the determination of the individual's capability to take a position of some special import, whether that be an astronaut or some earth bound job. The technique involved the utilization of the psychologic and the psychiatric information confirmed by extensive background investigation. After review of this information, discussion with the selectee was done in order to arrive at the best possible evaluation, allowing selection of persons for particularly demanding tasks and also providing information of value in predicting performance of these individuals.

The foundations of any good medical evaluation for selection or other purposes are a complete history, in some depth, and a very detailed physical examination. In addition to obvious abnormalities, these techniques normally are capable of demonstrating abnormalities not suspected by the individual himself. Use of the computer for history review and for storing physical and laboratory data has been invaluable. Some abnormalities and significant aberrations of health may not be apparent by these methods however, and the addition of laboratory studies involving the use of many specialized techniques are necessary. Indeed, they should be a part of many of the routine type of examinations when the supposedly healthy individual is being evaluated. Great strides have been made in utilizing some of these techniques on a routine basis. More will be said about some of the laboratory procedures later in this chapter. Latent disease or abnormality of function may be missed even by the use of all these techniques, however, and it may be that they could be noted only when the individual is evaluated in a dynamic functional state rather than in the resting or basal state. Most of the evaluations done by physicians are done in a static state, with the individual resting on the examining table, or an examining chair. The question of real importance is, "How do the heart, lungs, and the systems in which they act function when peak demands are placed upon them?" The interaction of the systems is also of importance. Dynamic testing may tax a single organ or organ systems function, and thus render a heretofore obscure malfunction observable. An example of a technique of this sort is the Masters Test, or so called "stairstep test", utilized by internists and cardiologists to help evaluate the function of the heart. In our continued selection and annual evaluation of our astronaut crews, two such dynamic tests which really stress the body systems have been used. A bicycle which is connected to a computer, allowing a measurement of heart rate to set the amount of resistance in the bicycle pedals and thus the amount of work done by the subject has been used to evaluate the status of the heart, blood vessels, and lungs. The work load is increased automatically to the point where the examinees heart rate reaches 120. It will maintain just enough resistance or work load in the pedals to allow the heart rate to remain at 120 for some three minutes. The work load then will automatically increase so that the heart rate will reach 140, and then 160. It can be carried to higher heart rates, such as 180 if desired. The amount of oxygen utilized to produce this amount of work, and the amount of carbon dioxide produced by the body in doing the work are then measured, allowing one to determine the effectiveness of the body in producing work for a given amount of oxygen consumption. This is an excellent dynamic assessment of the body's capability to perform any of the tasks which it is daily called upon to do. It is a much more effective means of predicting the performance of an individual than the taking of the blood pressure, and the electrocardiogram in a static in a static state, lying on the examining table. Another test which also acts to stress the cardiovascular system (heart and blood vessels) is onewhich was designed particularly to try and simulate some of the effects produced by the environment on this body system. Lower body negative pressure is the use of a tanklike or boxlike enclosure for the lower portion of the body in order to decrease the pressure on that portion of the body and thus, in a sense, suck the blood into the lower half of the body.

The container seals around the waist, and the individual looks somewhat as if he were in a magicians show, ready to be sawed in half. In actuality the pressure change is mild, reducing the pressure inside the box, or canlike container, by 30, 40, and finally 50 mm. of mercury below atmosphere or room pressure. The various reflexes which help return the blood to the heart when one stands on the surface of the earth are thus brought into play as the body tries to return blood to the heart against this negative pressure gradient. This is an excellent stress test or dynamic test of the function of the heart and blood vessels and their various reflex systems. Indeed these stress tests have proven of such value, not only in selection and continued evaluation, that they will be used in flight during the Skylab series in order to evaluate and predict the performance of the body systems upon the return of the astronauts to earth and the 1-G environment.

Training:

The training required of an astronaut is complex and involves many scientific areas as well as much detailed training in the operation of the spacecraft systems. A crewman who understands the possible physiological or psychological effects of spaceflight is better able to handle and to describe the effects when they occur. A series of lectures and demonstrations has been used after selection of the crewmen and training opportunities such as centrifuge or altitude chamber runs were also used to expand physiologic knowledge. The 28 and 56 day flights of Skylab with the large number of medical experiments and the greatly increased supply of diagnostic and therapeutic medical equipment required some special medical training of our crews. These experiences will be illustrated to see if the lessons learned can be of value in training paramedical people for roles in providing medical care here on earth in the future.

Spaceflight created some particular training problems for astronauts could not train by flying spacecraft as they had with aircraft. When they did fly the spacecraft it was for the first time and "for real". Special ground based trainers had to be designed and they had to be capable of simulating virtually every phase of the spaceflight. They were so well done that now the airlines are training their 747 and 707 pilots in trainers designed on the spaceflight principles to simulate all phases of airliner flight. Take off, landing, etc. is very real, including displays, noise, and even some sensations of movement. Airline pilots now can use actual aircraft for only a very few hours, thus saving a great deal of money for the airlines and making it a safer training operation.

Maintenance:

Once an individual is selected as an astronaut, his retention as a crewman on flying status becomes of great importance because of the large amount of money invested in his training. The task of the physician in space medicine as that of the physician in aviation or aerospace medicine is assuring that we keep every astronaut or pilot flying if there is no risk to the individual's, psychologic or physiologic well being, and he poses no risk to others. This implies the development of techniques for a continual evaluation of any possible medical or psychological deficits of a crewman on an individual bases. Should such deficits be found, they are treated as expeditiously as possible in order to return the individual to safe flying status as rapidly as possible. If their temporary nature is not evident, then every effort must be expended to attempt to explain and hopefully remove the deficit so that the individual may return to flying. In short, the flight surgeon's job is to keep astronauts and pilots flying.

A number of the astronauts have had disabilities of a significant nature which have been handled in this regard. Astronauts who developed boney growths of the neck vertebrae pressing on the spinal cord and who developed boney fragments in the knee joint, have had them removed, and have subsequently gone to the moon very successfully.

Alan Shepard successfully flew the first U.S. manned spaceflight on 5 May, 1961. Two years later (June, 1963) he developed symptoms of decreased hearing and ringing in the left ear accompanied by intermittent episodes of dizziness-spinning sensations-with some nausea and vomiting. As the symptoms persisted it became clear that they represented a condition called Meniere's Disease. Due to the possibility of developing symptoms at anytime he had to be removed from flying status. Medical treatment was effective for a while, but symptoms returned. Al's motivation to fly and his personal drive kept him from losing hope and in May, 1968, he agreed to undergo surgery to place a tiny tube between the fluid compartments of the inner ear and that surrounding the brain. This created a relief valve for any build up of fluid pressure. The operation was developed by Dr. William House of Los Angeles, California,and he performed it on Al. The results were gratifying and tests in zero-g-parabolic flights in aircraft, centrifuge, altitude chamber, etc.,showed no adverse effect. Thus he was requalified to fly both aircraft and spacecraft and in January, 1971, he very successfully commanded the Apollo 14 flight to the moon. His performance was not only a personal triumph of motivation and drive, but was evidence that flight surgeon physician and patient can successfully work together to achieve the goal of having every astronaut or pilot possible qualified to continue his flying career. Several physicians and politicians cautioned against allowing Alan to fly the Apollo IV Mission. I was convinced we had shown him capable of undertaking the mission and no one was more elated than I when this 47 year old astronaut completed his lunar surface exploration and returned home to show virtually no physiological change due to flight in contrast to previous crewmen. For added measure, he is the only crewman who ever gained weight on a flight-one pound.

Deke Slayton, also one of the original seven astronauts, has never made a spaceflight. In 1959 an abnormal heart rhythym was observed while he was on a centrifuge training exercise. This abnormal heart rhythym resulted from extra beats coming from the upper chambers of the heart and is called atrial (upper chambers of heart) fibrillation. It can affect the capability of the heart to function well as a pump of the blood. In 1962 he was removed from spaceflight status and,most severely disappointing to him, from flying the second manned orbital Mercury Mission. Repeated testing and observation over the years showed the episodes of abnormal rhythym to be more frequent, and he was finally put on medication in 1967. The medication (quinidine) stopped the abnormal rhythym and then was finally discontinued in 1969. He has had no abnormal rhythym since August, 1969. Still having no evidence of the cause of this difficulty I discussed the possibility of a detailed study of the heart by catheterization of the heart, placing of a dye you can see on x-ray in the vessels and heart and evaluation of the heart in this manner on a treadmill. Deke was still motivated to fly and to know as much about his condition as possible so the studies were done at the Mayo Clinic by Dr. Robert Maikin. They demonstrated a completely anatomically normal heart which was functioning normally. Again a difficult decision has been made and Deke was returned to aircraft flying on 13 March, 1972, and he may also be considered in the pool of crewmen available for future spaceflight .

Physicians who are concerned with the health of those on the ground, as well as those of us who are concerned with the health of space crewmen, really want their patients to be able to do those things which they desire to do and are trained to do. The techniques of individual evaluation combined with motivation, on the part of the patient show us lessons applicable to medicine as practiced on the ground. They can help to improve the individual health of all.

Preventive medicine as discussed in Chapter V must receive more emphasis in future health programs. Much can be gained in preventing disease and thus reducing the treatment load as well as the individual disability produced. Our experiences in preventing disease in the flight crew population year around, as well as just before, during, or after flight will prove to be of value as we extend health care here on earth. The techniques of establishing norms for individuals, maintaining serium banks, and developing more definitive methods for the detection of disease before symptoms appear, will all contribute to the future maintenance of health for all the crewmen and women of spaceship earth.

Natural and Artificial Environment:

When we have selected and retained the space crewmen, we must provide an artificial environment to insure his health in the hostile natural invironment of space. The natural environment, which has previously been described, is characterized by a vacuum, by radiation, and particularly by weightlessness. While protection must obviously be provided, the weightless environment certainly does offer certain opportunities, both for the evaluation of man's physiology in his peculiar environment, and for the study of certain processes which are also of value to man. Biologic fluids, such as vaccines, have been purified and separated by the use of electrophorases or the technique of using a positive and negative pole to separate the material along an electric gradient: In a gravity environment, the particles tend to settle out before they can be attracted electrically, and studies are currently underway to see if this phenomenon of weightlessness can help in this technique. If so, the natural weightless environment may have proven to be a boon by helping us produce purer vaccines and other biologic fluids. Man's vestibular system, that collection of organs in the inner ear which allows us to determine our position, has the only gravity sensor in the body. A true study of the physiology of this system, its normal and abnormal responses, and thus the possibility of understanding diseases which afflict it, can best be done in the weightless environment. Here the pure responses of this system may be studied in detail, and thus new approaches to the physiology of man, and eventually the determination of normal and abnormal function, and thus treatment may result.

The weightless environment has also given us the opportunity to study the function of the heart responding to the lesser demands of pumping weightless blood. New physiology is being pioneered as we see heart rates of 28 in normal healthy persons asleep in the weightless world of space. Here also we learn about the pressure sensors of the heart and blood vessels and perhaps information of value in our earth studies of high blood pressure will evolve.

While we have had exposure to only minimal doses of radiation inflight thus far, we have been concerned about the total radiation dose an astronaut may receive in his lifetime. Careful records totaling the radiation received from any source are kept on each astronaut. This requires proper dose determination of diagnostic procedures like chest x-rays, dental x-rays, isotope studies, etc. Our space oasimetry is also being used now to measure accurately the radiation doses being given to treat various malignant conditions like cancer. These accurate measurements have saved discomfort, the vomiting of overdosage, and even lives. Thus even our attempts to measure and protect man against the natural environment can have marked benefit to mankind.

Much hardware has resulted from our attempts to provide an artificial environment for man in space. These various hardware systems are called environmental control systems, life support and crew equipment, and range from complicated systems providing pressure, temperature and atmosphere control in the spacecraft, to those for the provision of water, food, and the handling of liquid and solid body waste. In addition to the cabin, we have provided space suits which can be used as backups should we loose pressure within the spacecraft itself. They may also be used to protect the crewman as he ventures outside the spacecraft or onto the surface of the moon. Much of the hardware to protect man from the space environment, and the research necessary to develop it, has proven to have wide terrestrial application.

The photographs and television views of the astronaut in his spacesuit are common knowledge and widely accepted by people around the earth. The space helmet so sommonly viewed, has been used as a model to make it easier to obtain oxygen consumption data on children. The commonly used method employs a nose clip and a mouth piece. These are uncomfortable, even to the adult, and particularly uncomfortable and frightening to the child. In addition, they tend to restrict free air flow. The space helmet was thus used as a model and modified by using it with a neck seal and then supplying an air inlet and outlet. The outlet part could be connected to a oxygen analyzer and thus the oxygen consumption could be comfortably obtained. Our need to obtain good data on the metabolic rate of crewmen as they do particular tasks in a spacesuit, has led us to continue development of better techniques for obtaining oxygen consumption and carbon dioxide output rates inside the spacesuit. This continued research and development effort will also continue to have benefit to our earthbound patients.

The helmet liner material is lightweight, tough, resilient, and can be made form fitting by foaming it in place for custom fit.

A medical need was envisioned for this material when a substance with the same properties was desired for making such orthopedic devices as arch supports customized to the patient while he was being seen by the physician or therapist. This could relieve long waiting periods and in a fifteen to twenty minute time period,provide the patient with a theraputic device which could be immediately checked by the physician. It is being used in several centers at the present time.

Another foam material, polymethane foam which has been used to absorb energies and produce fitted support, has been used to reduce the incidence of bed sores caused by the continuous pressure on weight bearing points of the patient confined to bed due to such things as spinal cord injuries. The use of this foam as padding material has proven to be highly effective in reducing the occurence of bed sores. It too, is being used now for prosthetic and orthopedic devices.

The use of a high oxygen content environment in our spacecraft led us to the search for fireproof materials for our spacesuits and other items carried in our spacecraft. Beta fiber which is made of glass has been woven into materials which were nonflammable. The material remained soft and pliable, however, it tended to wear and fray easily. It was found that by coating the glassfibers with teflon, the material could be made more abrasion resistant. The outer layers of our spacesuits and many items carried in the spacecraft have this fire retardant material as a cover. There are continuing efforts toward development of better fireproof materials due to our needs within the space program, and we have a large materials development program underway. Those already developed have been put to wide use in potentially hazardous areas like high pressure operating rooms, hospitals, and for the use of firemen. Clothing, sheets, pillowcases, and other materials which must be used with patients can be made much safer by the use of such material. Fire resistant or retardant materials also can have wide application in our homes. Another material which has been used in the space program for various insulating and padding purposes, is polyurathane foam. This has been shown to have excellent insulating qualities, and has recently been tested for use in aircraft where it can be shown to provide a reduction in the heat from an aircraft fire for a period long enough to allow passengers to escape.

Another device used by our astronauts as protection against the effects of the accelerations produced by aircraft flight, is the anti-G suit. This suit has been used for years in aircraft, and it also has now found a place in medicine by being used as external counter pressure on the legs and lower abdomen in individuals who tend to have reduced blood pressure on standing upright. The G-suit has been helpful in maintaining proper return of blood to the heart from the lower extremities and thus precluding fainting or loss of consciousness by such patients. We are currently using a modification of the old capstan partial pressure suit as a garment to put counterpressure on the legs prior to the astronaut standing up after landing in the spacecraft. We have used it on Apollo17 and may use it in Skylab. This capston suit can be used in many instances where circulation support is required. In addition, a recent effort has been initiated to try an anti-g suit as a counter pressure garment for young hemophiliacs. The suit could be inflated by use of a small gas cartridge which would be activated if the child should fall in play and thus have the potential of bleeding internally into joints and tissues. The external counter pressure would be most helpful in trying to reduce the amount of this bleeding. There again the new capston suit developed to protect our astronauts may be of even more value.

Another portion of the space suit which we have had to develop in order to allow our crewmen to do the large workloads required on the lunar surface has been the water cooled undergarment. This is a device composed of tiny tubes which carry water which is cycled through a heat exchanger. The surface of the body is thus in direct contact with a layer of these tiny tubes of circulating water, and the body heat can be transferred to the circulating water by conduction. The heat can then be removed from the water as it passes through the heat exchanger. This is a very effective method of keeping the body cool, and is much better physiologically because it does not use the body as a sponge, requiring sweating, and then convection by air movement to remove the water produced as sweat and thus cool the body. The use of the water cooled undergarment and conduction, thus reducing sweating, helpsrto maintain adequate fluid and electrolyte balance in the body. Such water cooled undergarments are now being utilized in patients who have high fever. They can be much better controlled than the old method of using ice water tub baths. They are also being investigated for use with hypothermic anesthesia. An obvious use outside the hospital but one which also contributes to the health of man is that by firefighters. They wear them inside garments made of fire retardant materials, as do race car drivers who find the temperature in the race car can reach very high levels. The water cooled undergarments are currently being used in both these instances, and very effectively.