MODERN TRENDS IN AVIATION MEDICINE

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Aviation Medicine is not a static science. As aeroplanes become more complex, fly faster and higher, Aviation Medicine progresses and expands often with staggering rapidity. I emphasize the dynamic nature of this relatively new Science in order to counteract prevalent tendencies which assume that what was good enough 5 or 10 years ago, will be good enough to-day or tomorrow.

It was not so very long ago that the very term "Aviation Medicine" had little meaning in India. To-day, there is a growing realization that the conceptual entity, that this term stands for, is of considerable importance for the progress of Aviation. There is an ever growing consciousness amongst men who fly, even in India, that their progress and well-being is largely dependent on adequate and proper medical backing.

In some circles the practice of Aviation Medicine is narrowed down to aircrew and their immediate environment. In others, the environment is thought of purely in its physical attributes and its physiological effects on the human organism. In still others, emphasis is given solely to the maintenance of the physical fitness of flying personnel. The truth is that Aviation Medicine covers all these points of view and much more.

Human Factors in Aviation.

If I were asked what was the most significant development in recent times, I would say it was the realization of the supreme importance of the human, the unknown factor, in Aviation. It is being increasingly appreciated abroad that the human factor plays a dominant role in all aspects of aviation quite apart from the mere act of flight itself. Thus the design and construction of aircraft, their servicing, maintenance and overhaul, the control of aircraft movements, the provision of navigational, radio and electronic aids, the construction, lighting and use of airfields, the executive and administrative services, are all influenced by man himself. It is patently illogical and probably also short-sighted to restrict the scope of Aviation Medicine merely to aircrew and their immediate environment, when all these supporting and ancillary services, so necessary for successful operation of aircraft in modern times, are also largely dependent on the human element. It serves no useful purpose to-day to prevent fatigue in aircrew, if the Duty Air Traffic Control Officer, for instance, is himself subject to such psycho-physiological deterioration. As will be shown later, such factors are becoming more important as the initiative and the freedom of action of pilots of modern aircraft grows less.

In this connection, I would like to quote to you from an article entitled "The Concept of Aviation Medicine" by Captain Ashton Graybiel, Director of Research, U.S. Naval School of Aviation Medicine. The article concludes:—

"This report began with a statement that the human element enters into nearly every aspect of aviational activity and in turn, these activities have important influence

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on the well being of man. In using the term Aviation Medicine, I suggest that we have in mind all of these aspects and all of these influences."

Lest you should feel that what I have said so far is only a concept in the minds of of some thinkers, let me inform you that the United States Air Force have already taken a big step towards enlarging and giving effect to it. They have established, since 1950, a Human Factors Division, in the Air Research and Development Command co-ordinating under one head the aero-medical, psychological and social sciences concerned in Military Aviation. These activities they have classified under the following Sections:—

1. Human Engineering.
2. Human Resources.
3. Aero-Medical Sciences.

Human Engineering.

It was appreciated many years ago that the physical and engineering sciences had produced aircraft whose overall performance was limited by the psycho-biological characteristics of the operator, rather than by engineering design or structural limitations. The need was felt then for teams of medical men, physiologists and psychologists to engage in joint effort with aeronautical engineers to produce the optimum man-machine combination. This resulted firstly, in a synthesis and application of existing knowledge in the various biological fields to plan aircraft design, and secondly to research on the human organism to discover his capabilities and his limitations. Displays and lay outs of instruments and controls were studied so that man could operate the machine efficiently and with the minimum of fatigue and danger. Aviation Medicine took on a new look, an intensely applied one.

Since then, much further progress has been made and Human Factors Teams have been given the task of co-operating with the engineers during all stages of the development cycle of complex aircraft of the future, the pre-mock-up phase being considered as most important. The following is a schematic representation taken from General Flickinger's account of B-52 Strategic Bomber Crew Effectiveness Planning by Human Factors Team.

Team Captain
(Flight Surgeon)

Anthropologist

Cockpit specifications.
Body comfort.
Functional limits.
Seat controls.

Physiologist

Environmental control
Oxygen.
Visibility

Biophysicist

Escape. Noise & Vibration
Emergency protection.
Protective equipment.

Psychologist

Work space lay-out.
Training requirements
Component design.

On the other hand, the study of man's psycho-physiological limitations led to interesting though diverse results. In many respects the machine, that is modern technological advances, had indeed out-stripped the capacity of organic man to adapt or acclimatize. It was soon realized that the human mind was infinitely more supple than the body and that whilst it was possible to make mental adjustments to many situations, man has relatively little margin for physiological adaptation to the vast majority of stresses encountered in modern flying. Perhaps one notable exception to this generalization is the work on crash injury research which has shown that the human body can withstand tremendous decelerations with little harm.

This situation has necessitated man utilizing his engineering skill to carry with him his own environment in order to maintain homeostatis. This is aptly illustrated by the use of oxygen above 10,000 feet, of pressure cabins and counter-pressure suits above 40,000 feet, of air-conditioning and of specialized flying clothing. This nevertheless gives rise to additional problems of safe-guarding the crew in the event of failure of the engineering device.

Human Resources.

The Human Resources Section is responsible for proper selection and classification of available man-power and for job analysis, so that the man can fit the job and the job the man. The improvement of training methods and devices also falls under this head. In addition, the social problems of human attitudes and relations, morale and motivation and psychological warfare are intensively studied.

In persuance of its main peace-time aim of preventing flying accidents, Aviation Medicine has studied the pilot in his environment, not only the physical environment of the atmosphere in which he flies, but also the social atmosphere of his home, his Squadron, his service and his country. In view of the psychological stresses resulting from the hazardous character of flight—it being recollected that more deaths and injuries result from flying per se, than from enemy action, Aviation Medicine has given special thought to, and engaged in special study of the impact of such hazards on the human mind. It has achieved a fine measure of integration of scientific knowledge applicable to the third dimension. In fact, it has enabled Flight Surgeons to practise medicine as it should be practised from the environmental, the preventative, the social, and the psychosomatic points of view. Its outlook is broad and its scope enlarging daily into a social science of considerable importance to mankind, in sharp contrast to the narrowing of interests in other medical spheres. Ever since its inception, Aviation Medicine has been metaphorically, a breath of fresh air to the medical profession.

Aero-Medical Sciences.

The section on Aero-medical Sciences deals with research and development related to the stresses of flying. It embraces what we have up to now considered as Aviation Medicine, and includes also the conventional specialities, geriatrics, aerial hygiene, air evacuation and psychiatry, as specially applicable to aviation. To schematize,

HUMAN FACTORS

HUMAN ENGINEERING

Fitting the man, the airframe, the power plant, the electronic devices, and the armament into an operational unit—the weapon system.
Instrument and control display, and lay out.
Cockpit standardization. Human Factors Teams.

HUMAN RESOURCES

Sources of man-power.
Selection & classification. Job analysis,
Fitting the man to the job.
Improving training methods and devices.
Study of Human relations.
Attitude. Morale. Motivation.
Social sciences.

AERO-MEDICAL SCIENCES

Stresses of Flying.

- Barometric Pressure
- Temperature. Humidity
- Speed. Acceleration. Noise
- Vibration. Toxic agents
- Visual problems.
- Prevention of accidents
- Fatigue.
- Psychological factors of danger.

Conventional Medical sciences.

- Geratrics.

Air Evacuation.

- Aeriala snitation.

Push-Button Flying.

I am sure the engineer would like to eliminate man, the unreliable, from his calculations, as provision for the latter's safety appears to be the biggest hurdle in aviation progress. Already the pilot is not the master of his own actions as he used to be in the good old days. Given a suitable landing ground he had initially only to contend with a relatively simple machine. His whims and fancies, his initiative and dare-devilry had full sway. Such were the pilots of World War I. and to some extent those of World War II also. But all this is now changed.

To-day, long before his sortie begins, the modern pilot is under a strict regime and close supervision. He has to spend hours in flight planning; in briefing by Intelligence officers, by weather merchants, by navigation leaders and operation officers; in pre-flight checking his aeroplane; in properly clothing himself; before he even settles down in his seat. Even then he is not his own master. He must go through an elaborate cockpit check and obtain detailed instructions for take-off. He must follow scrupulously the flight-path ordered and take instructions from his navigator or from his sector control. If the weather is bad on return to base, he can't even land his own aeroplane, except for the final touch-down.

The question has been asked whether it would not be better to replace this human automaton by a mechanical robot in the interests of efficiency and reliability. There is no doubt that in these days of electronics and guided missiles, manned flight, certainly for carrying a war to the enemy, man may be entirely eliminated. In fact, an age of pushbutton flying and push-button warfare does not seem to be too far away.

Much as we might like to remove man as the controlling agent in the aeroplane, however, the trouble is that the agents of War become such complex machines that highly trained men have to service and look after them. The human factor is merely shifted from one phase of the total situation to another. We cannot get away from this human factor. In the final analysis man must press the button.

In addition, we must also think of two other factors, the harm and the good aviation does to mankind. On the debit side is the death and destruction which aviation brings in its wake, and also the harmful effects of annoyance and transmission of illness. On the credit side, aircraft manned by men, not robots will always be needed for the evacuation of casualities, for the bringing of succour during natural calamities, and for the transport of personnel. We must also not forget the adventurous nature of man. As long as there is aviation, as long as there are hopes of breaking records or reaching the moon, man will be in the aeroplane.

Space Travel

This is of course, the most intriguing trend in modern Aviation. It fascinates and yet it frightens. It fascinates because it presents the human race with the possibility of another foothold in his progress towards unravelling the riddle of the Universe. It is awe-inspiring because of the unknown factor. It would not be out of place to touch briefly on some of the issues involved, especially as they bear directly on the principles to which I have already referred.

It is well established that a projectile has only to reach a velocity in the range 18,000 to 25,000 m.p.h. to be able to pull away from the gravitational mass of the earth and coast in space. It is for the engineers to say whether they can produce the necessary power-plant to make such speeds possible; suffice for us to remember that the Hurricane flew in 1938 with tail-wind assistance from Edinburgh to London in less than an hour, at a speed of about 400 m.p.h. Six years later the V2 rocket had attained 9 times this speed and the rocket is now more than a decade old. We also have before us the possibility of the use of atomic or thermo-nuclear power. It has been reported that it is planned to celebrate the International Geographical Year in 1957-58 by launching an artificial moon which will circle the earth every 90 minutes and telemeter back scientific data.

Some years ago, the Medical Services of the United States Air Force set up at Randolph Field, a Department of Space Medicine in order to study, in consonance with the principle of pre-planning, the medical problems of space travel. Much work has been carried out since and as far as can be predicted the major problems likely to confront man have been defined and some studied. What is interesting to note is the systematic way in which present knowledge about Space has been collected from the various fields of astronomy, mechanics, nuclear physics, cosmology, metereology, and applied to the subject; initially on theoretical grounds, followed by actual experimental studies. The problem of weightlessness is an outstanding and extremely interesting example.

Weightlessness.

At exceptionally high altitudes reduction or entire elimination of weight ensues under coasting conditions, because mechanical support by the atmosphere is lacking. In addition, the velocity of the aircraft about the centre of the earth, gives rise to a centrifugal force which tends to counter-act the aircraft's weight and of course the weight of everything inside.

Whilst a considerable amount of information was available on the effects of increased "gravity" on the human body, acting both positively, in the direction head to foot, and negatively, in the direction foot to head, nothing was known on the effects of reduced or zero-gravity state. Information on this was most necessary for planning manned flights into Space. On theoretical grounds a number of methods were considered in order to produce "kinematically", reduced gravity conditions on earth. Of these the free-fall was extremely limited in duration due to the development of frictional forces which neutralized the downward acceleration. The use of lifts in sky-scrapers was also mooted and a vertical parabolic flight path for an aircraft worked out on the theoretical mathematical considerations. This latter technique held possibilities of creating a zero-gravity state lasting up to 35 seconds for experimental purposes.

On the physiological side it was argued that the lack of normal 1G stimulation of the gravi-receptors of the body, the otolith organs and the pressure sense organs of the skin, would result in a sensation of falling under zero-gravity conditions and arguing on the basis of some of the sensory illusions met with in flying under increased G, might have peculiar results. For example, in a gravity-free system, a human body moving from A to B would need to propel itself from A and stop itself at B. The acceleration required to get away from A would give the impression that A was "downwards" in the orientational sense and on reaching B, the breaking at B would be expressed sensorily, as if B was downwards. Hence an illusion of rotation of the body during the movement from A to B would be created.

The role of the visual sense was also considered. In the absence of gravity, the "roof" of the space-ship cabin would, of course, be considered as "up" and the floor "down", irrespective of the man's position in relation to the centre of the earth. Whilst some experiments on the sub and zero-gravity states had been done before World War II by the Germans in vertical aeroplane dives, recently the experimental data have been augmented by actual reproduction of the parabolic Keplerian trajectory referred to previously using human subjects and also by photographing the behaviour of animals during V-2 and Aerobee rocket ascents.

Other Problems of Space Travel

In like manner, other hazards of space travel are being systematically investigated. Unfortunately much of the earlier work on Cosmic rays was directed exclusively to the study of nuclear phenomena and the data obtained could not readily be applied to assessing the biological effect of such radiations at different altitudes or in actual space.

The possibility of collision with meteorites presents peculiar problems which may finally be resolved by electronic and engineering techniques.

It would appear that the question of air-conditioning the space ship, controlling the temperature, and supplying the required amount of oxygen are not insuperable, whilst sufficient data are available from acceleration studies to plan the G forces required to reach escape velocity and for subsequent deceleration at the time of return.

Conclusion.

The human factor pervades all aviational activity and a case for the extension of the "concept" or the "complex" of Aviation Medicine to cover all such activities is now well established.

The prospects of human "Space Travel" are drawing nearer as a result of medical research and technical development.

As far as eliminating man from the plane, the time is not yet ripe. The greatest argument against eliminating man is, I may quote:—"Pilots fly because they have a sort of incurable disease. They need to fly, as men need to breathe or make love."