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ANALYSIS OF THE AVIATION MEDICINE SITUATION AND RECOMMENDATIONS FOR A BUREAU PROGRAM

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CONTENT

Analysis of the Aviation Medicine Situation and Recommendations for a Bureau Program

SUMMARY

The purposes of the work reported herein are to conduct a survey of various research facilities adaptable to or engaged in a study of pilot fatigue factors and outline a program of investigation It was necessary to obtain information relative to existing or projected efforts of this nature as well as their state of attainment and desirability Attention was given to the administration, personnel, and physical properties of many institutes and agencies Conclusions have been reached and recommendations made for Bureau sponsorship of investigation in this field

INTRODUCTION

Improved matériel has enlarged the scope and performance of aircraft This has created a demand for greater human accomplishment The existing trend of further advances in design tends to amplify this element Present methods of evaluating personnel technique, capabilities and limitations, originated when airplanes and flying were in an elementary status They provide for no scientific determination of the effects of mental or physical stress incident to modern operations The existing problem is to ascertain the cause, effects and remedies with respect to Pilot Fatigue and to establish methods of human selection and maintenance that will insure safe performance and a longer period of industrial usefulness The author believes a solution lies in an intelligent application of the findings of pure science and experimental clinical medicine to human biology These offer a means for creating new gauges This principle is applied in other industries to promote safety and human welfare A comprehensive survey and inspection of research centers was made

Agencies engaged in the fields of pure science such as biochemistry, biology, physiology, biophysics, etc, and those of experimental clinical medicine, particularly the industrial application of the latter, were visited Isolated research workers, as well as interrelated, well-administered institutes, were considered with the view of enlisting all phases in a comprehensive study covered by a long-range plan

The following grouping is given to distinguish the character and purpose of the various agencies

A Military and Governmental Services

1 Army aviation medical activities
2 Navy aviation medical activities
3 Bureau of Air Commerce aviation medical activities
4 Public Health Service

B Scientific Societies or Associations

1 Aero Medical Association
2 National Research Council
3 American Medical Association and its Sectional Groups

C Schools and Universities
D Airlines and Airline Medical Directors
E Research Institutes
F Independent Research Workers

DISCUSSION

1 Army Aviation Medical Activities

(a) Wright Field Physiological Laboratory

This is a part of the Air Corps Engineering Laboratories The entire activity is housed in their buildings Personnel consists of a director, who is a flight surgeon, a physiologist, technicians, and clerical staff The equipment and

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apparatus are adequate and the laboratory advantageously designed Results seem to be well tabulated and correlated

Studies are listed under "Air Corps Projects" Each is given an identifying number, a priority status, and a completion percentage

The main effort is toward the determination of effects of pressure changes and of anoxemia on human and animal physiology Simulated and actual flying conditions are used to produce symptoms Study is being made regarding centrifugal, centripetal, and gravitational forces and the resultant physiological alterations

(b) Air Corps School of Aviation Medicine

The principal objective here is improvement of selection and predetermination of flying adaptability of trainees The trend of investigation follows that line

Heavy teaching schedules (active classes and extension courses) and numerous cadet physical examinations limit the faculty's time and precludes research

Primary flying classes offer the material The author does not believe that the factor of pilot fatigue is manifest in a training schedule of this nature, as the aggregate flying time is less than 300 hours per year

Masses of data have been accumulated in an effort to correlate Schneider index ratings with flying aptitude and visual reaction time performance with success or failure to complete training Recordings on the Mashburn-Constable apparatus show good results in correlating failures of the slow-reaction groups

No relationship between normal electrocardiograms and flying adaptability has been found to exist However, a few electrocardiographic tracings have been made on older pilots for cardiac diagnosis From these findings one must concede the clinical necessity of electrocardiography in a routine maintenance examination of pilots who have passed 40 years

Continued work has been done on revision of the personality study and psycho-analysis—all with a view to bettering selection

Work has progressed on a practical test for visual acuity under reduced illumination using standard clinical equipment This appears to fit into more extensive investigation done elsewhere in physiological optic research

An apparatus developed by Darrow of Northwestern University Child Behavior Clinic has been purchased This machine attempts to evaluate circulatory, neuro-muscular, respiratory, and psycho-galvanic reflex changes in auditory visual, tactile, and emotional stimuli variations by means of graphic recordings So far only the tracings of pulse and blood pressure have been used for flying adaptability determinations

2 Navy Aviation Medical Activities.

The Secretary of Commerce has solicited from the Secretary of Navy participation and cooperation in this project Use of an airplane for experimental flying has been proffered

No research of pilot fatigue is conducted or contemplated by the Navy Aviation medical facilities of the Army Air Corps School of Aviation Medicine are utilized and Naval flight surgeons receive their training at this institution

Essentially the Navy is interested in developing better selection methods Present investigation constitutes long-range observation of psychological factors in trainees who fail to show flying adaptability Some study has, in the past, been made regarding the effects of acceleration, deceleration, and gravitational forces

Except in specific types of flying i e , pilots in big boat squadrons, it is thought that there is no appreciable pilot fatigue during peacetime Naval operations

3 Bureau of Air Commerce Medical Section

The function of this section is administrative It provides data for statistical information relative to physical requirements and condition at times of certification

This section has material for analysis which might be utilized in the scope of the proposed investigation

4 Public Health Service

Development of quarantine measures and methods of pratique of passengers and pilots was discussed with the Public Health Service

Statistical and research data relative to activation of bloodstream infection and plasmodia was requested by the author in order that investigation and recommendation might be made regarding the eradication of transmissible disease through these channels

The effects of fumigation on structures of the aircraft and methods of destruction of disease carriers were considered

In the industrial fields, considerable work has been done which could be utilized in the scope of this investigation Studies of industrial hazards such as carbon monoxide, lead poisonings, etc , have been carefully considered by the Public Health Service

5 Aero Medical Association.

A committee which is representative, was appointed by the president of this group at the request of the Bureau This body has met and advised with representatives of the Bureau This association is composed of medical examiners of the Bureau of Air Commerce and flight surgeons of the Army and Navy

Recommendations from its members were in substance as follows

(a) That an investigation of Pilot Fatigue be made from the standpoints of pure research, clinical medicine, and statistical data

(b) Pure research to be allocated to an established laboratory

(c) Clinical research to be developed by the Army, Navy, and Commercial Airlines

(d) Statistical data to be obtained from the existing records of the military services and the Bureau of Air Commerce

(e) Coordination and direction of studies to be undertaken by the Bureau of Air Commerce

6 National Research Council

The National Research Council is a semigovernmental body created by executive order of the President and organized by the National Academy of Sciences which in turn was established by an Act of Congress for the purpose of investigation, examination, experimentation, and reporting on any subject of science or art, at the request of any department of the government

Meetings of the National Research Council have been attended, and their members are acquainted with the effort being expended by the Bureau toward the careful alignment of a study

It is believed this body as a whole, or a special committee on which a representative of the Bureau is serving, may be helpful in making suggestions in fields of specific research which pertain to this study

7 American Medical Association

The American Medical Association is the parent group of organized medicine

Research fellowships are sponsored by this body and through its specialized groups a wealth of scientific clinical medical data is available

Sections such as those in cardiology, opthalmology, neuro-psychiatry, otolargyngology, rentgenology, et al, have available experimental research findings in the special fields of clinical medicine

8 Schools and Universities

The following schools and universities were visited or contacted through one or more of the departments which were considered as being equipped to undertake a phase of this study

University of Pittsburgh
Carnegie Tech
University of Chicago
Northwestern University
St Louis University
Washington University
University of Kansas
University of Texas
Tulane Medical School
Duke University
University of Wisconsin
University of Michigan
Johns Hopkins University
Yale University
Cornell University

New York University
Columbia University
Harvard University
Dartmouth University
University of Pennsylvania
University of Illinois
Western Reserve University

The author will make no attempt to detail the exact nature of apparatus, personnel endowments, facilities or scope of investigation or research in each university surveyed For purposes of illustration some of the outstanding results of their endeavor are cited as follows

(a) Chicago University—oxygen reduction processes in physiology, measurements of sleep and cortical activity, alcohol and sugar metabolism

(b) Northwestern University—recording of behavior changes resulting from emotional stimuli—vitamin and acido-alkaline base balance change influences, advanced serology

(c) Washington University—Hormone and endocrine action effects

(d) Tulane — dietetic influences, tropical medicine, antigen and antibody serology

(e) Duke University—Phychology, biochemical changes in fatigue

(f) *Wisconsin—oxygen and anoxemia physiology*

(g) Johns Hopkins — Opthalmology and physiologic optics, nervous physiology in biochemical changes, effects of toxines and catylizer enzymes

(h) Yale University—industrial application of physiology, psychology—food chemistry—oxygen effects

(i) Cornell—new delineation of physiology and anatomy of thought and intelligence centers—circulatory measurements

(j) Dartmouth—geometric and physiologic optics—development of aniseikonia lenses and application tests

(k) Western Reserve—Kinetic force and endocrine function in brain and central nervous system function Oxygen reduction processes—circulatory changes

(l) University of Illinois—exhaustive study of effects of climatic environmental forces and anthropological considerations

(m) At Harvard University through the Fatigue Laboratory, and at the University of Pennsylvania, through the Johnson Foundation, there is manifest an interest and expressed a desire to attempt an organized research of factors which are to be outlined by the Bureau

The Fatigue Laboratory, housed in Morgan Hall, is a component part of the Harvard University School of Business Administration and is under the direction of Professor Lawrence Henderson *This institution represents* an investment of over one million dollars, has been established a number of years, is staffed by a group of carefully selected and proven scientists and possesses endowments and income adequate for its needs Its existence is due to recognition of the importance of adaptive measures and investigation of human biology in industrial progress All of the resources of Harvard University and its allied groups are at its command In close collaboration are the School of Public Health and Hygiene the Harvard Medical School, School of Engineering, Massachusetts General Hospital and allied Hospital Groups, etc Results accomplished in past studies have been justified by universal acceptance and the benefits derived indicate further usefulness

An allocation of half the time and efforts of this laboratory, a gift of scientific apparatus and use of the facilities by the Bureau personnel engaged in this work have been offered in a proposal submitted to the Bureau Based on their estimate of cost it appears that Harvard would provide funds equal to those used by the Bureau in the event of a contractual arrangement is made This proposal, possibly modified to meet the specific needs of the industry, *should be given careful consideration*

(n) University of Pennsylvania Johnson Foundation, under Drs Stengle and Bronk have housed in one building all the research efforts in biochemistry, biophysics, physiology, psychology—clinical experimental medicine, etc This represents seven years' trial and effort and an investment of $1,800 000 00 The endowment and funds for maintenance are ample for continuation and progress Closely

adjacent and in intimate association are all the components of the University of Pennsylvania Medical School, the graduate schools, and the 2,500-bed Philadelphia General Hospital and its associated groups, staff and graduate students, technicians, etc The engineering, economics, and other scientific departments are in an interrelated manner tied to the research foundation

In many schools only a part of a research study could be undertaken due to lack of facilities, interest, funds, or administrative direction Isolated studies, which might be correlated into a component whole, are being carried on in most of these institutions In some, a well-administered coordinated group, with interrelated specialties, is capable of undertaking a study comprising many elements of pure science and their clinical application

In summary of schools and universities, facilities and personnel are available, and interest is manifested toward an attempt to solve the problems of aviation medicine through scientific research methods.

9 Airlines and Airline Medical Directors.

Prior to the formation of the Safety and Planning Division the directing head of the Air Transport Association of America expressed a desire to see a program such as is now contemplated put into effect As this is in the best interest of the industry it is assumed this group will continue to support the project

American Airlines, Inc , have maintained a medical surveillance of pilot personnel for the past nine years At present this company has a medical director who determines its policy and methods Under him a part-time staff of medical examiners, consisting of local physicians residing in cities where pilots are based, conducts periodic examinations of pilots operating scheduled runs The director has expressed a desire to cooperate in a Bureau sponsored and directed program They sponsor no research

United Air Lines has recently begun the organization of a medical department with a full-time medical director It has not been determined at this time what the methods of procedure will be The department is new and the director is formulating administrative plans From a conference with him, we infer cooperation with the Bureau will be in accord with their activity

Eastern Air Lines, using a full-time medical director, operating a central office with good equipment, has, during the past year and a half, made a careful medical survey of its pilot personnel

This is an application of clinical methods of preventive medicine It has been justified by results obtained in the eradication of physically unfit and correction of pathological conditions both manifest and incipient

It does not, however, comprise research study, unless one may say that, in a broad sense, the collection of clinical data and the determination of their effects on performance over long range operation, constitutes such.

No information is available regarding contemplated medical programs of other domestic air-line operators Contacts have been made with TWA, Hanford, Braniff, Northwest Airlines, and Chicago & Southern

Pan American Airways has used on its Caribbean Division the medical facilities of Eastern Air Lines for a short time In addition it has contracted the services of a psychologist and physiologists for observation of anoxemia in the Andes and on Pacific flight operations These specialists have been consulted with reference to Pan American pilots' medical needs Some examinations of trans-Pacific pilots have been made, particularly Neuro-Circulatory Index Ratings and one experimental flight was made for oxygen depletion effects on crew and personnel

No survey of foreign airlines has been attempted and current literature on the subject is the source available with regard to their medical research activities

10 Research Institutes

In this field there are many industries which maintain studies or research groups devoting their effort to application rather than scientific evaluation Those surveyed were General Electric, Bell Telephone, Macy's, and General

Motors In addition, the Mellon Institute Rockefeller Institute Crile Clinic, and similar endowed centers concerned with problems of varied nature were visited These have been considered as potential sources of information particularly in formulating a program

11 Independent Research Workers.

Under this classification are grouped those individuals who are not connected with schools universities, endowed institutes, or employed by industry in connection with commercial enterprise, as well as the isolated studies not interrelated nor in a designed program carried on in any of the above Since time forbids a thorough investigation of individuals it is suggested, through focus of interest in this field, that people of this type be drawn into the program

CONCLUSIONS OF THE AUTHOR

As a result of the survey of various research facilities and observation of other agencies the author concludes that

1 No coordinated research of pilot fatigue factors is now in progress
2 Adequate means for coordinated study are available
3 Material development has surpassed methods of evaluating personnel technique
4 Present procedures are inadequate for determination of the effects of stresses imposed by the industry
5 New measurements for selection and maintenance are needed
6 Future safety and advancement of the aviation industry are dependent on an early solution of the existing human problems
7 The Bureau is the logical source for the prosecution of an effort to ascertain the causes and effects of and the remedies for pilot fatigue

RECOMMENDATIONS OF THE AUTHOR

It is recommended by the author that the Bureau

1 Establish an experimental medical station at a central location where flying activties are concentrated and varied, under the direction of a trained and experienced flight surgeon, who is equipped with adequate graphic recording clinical and experimental equipment and apparatus, and possessing a staff capable of carrying out technical procedures and tabulating records of the results

2 Sponsor and provide funds for an exhaustive study of the physiological, neurological and psychological effects on the human body produced by piloting present-day transport aircraft in scheduled operation and equipped with all modern avigation instruments and aids, including the automatic gyropilot control, and radio communication and navigation devices In addition, studies should be made on personnel under controlled and measured flight conditions and in simulated flight performance tests using a Link trainer

3 Conduct experiments on not less than fifty airline pilots in order to determine an average of performance level for the average airline pilot in the industry These subjects should provide a differential of age factor, physique, nervous and mental organization, experience and training Studies made should be under varying operating conditions Seasonal, climatic, and weather conditions, altitudes terrain, time of origination and termination of flight length of schedule, day and night performance rest periods, vacations, social, economic, and environmental conditions should receive consideration

4 Consider the detailed and complete medical history habits, social educational background mental scope and reaction, personality trends and tendencies, past performance record and in addition recognition of any disease or disorder, either organic and/or functional, which might influence fatigue production The latter condition to be determined by a thorough and comprehensive graphic clinical audit of the subject

5 Record and evaluate any measurable physiological, anatomical or psychological change in the individual which may result from fatigue produced by flying

6 Assign specific projects to appropriate agencies for development of new clinical meas-

urements This can best be accomplished by making awards of development contracts or allocating funds to supplement fellowship awards in established research centers Specifications drawn by the Aviation Medical Specialist should outline what is desired of the agency Capabilities and facilities of the individual or institution should be approved Assignments of studies in anoxia, physiology, bio-chemistry and for the determination of emotional reaction stimuli measurements should be made to Northwestern University Harvard University, and the University of Pennsylvania

7 Coordinate effort among various agencies and correlate available research data and findings through the following procedure

(a) Appointment of a small but active committee consisting of representatives of the Army Medical Corps, Navy Medical Corps, Public Health research division the National Research Council, and those members of research institutions under contract to function at regular intervals and aid the Aviation Medical Specialist in an analysis of the problems and suggest methods of solution

(b) Interchange of personnel and facilities between the contracted research agencies and the personnel and facilities of the experimental station and provide for experiments by members of contracting groups at the Bureau experimental station as well as for consultants at stated periods for special work

(c) Prepare a bibliography of published reports dealing with phases of this study, with an index of references of results and their possible application, for dissemination to allied agencies

8 Evaluate results of scientific research and conduct experiments leading to the adaptation and application of the new clinical methods of measurement developed in order that they may be proved under conditions of actual operation at the experimental station

9 Project new studies as the need arises

10 Make recommendations based on conclusions derived from analysis of the results of this investigation in order that safe practice may be encouraged and that safe regulations may be drafted

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