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1. Title: Central venous pressure changes during high +Gz maneuvers and weightlessness during flight

2. Project/Task/Work Unit: 7930-03-025 AIR1.941130.036c

3. Investigators: George H. Cohen, Captain, USAF, MC
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4. Technical Consultant:

5. Technical Objectives:

a. Design, fabricate and test a reliable, safe system for the measurement of direct intravascular pressures during high performance flight.

b. To determine changes in cardiac filling pressure (as assessed by mean central venous pressure MCVP) during high G loading and weightlessness.

6. Background:

a. Current systems of blood pressure monitoring during dynamic situations such as high performance flight have been understandably limited to indirect methods using variations of the Korotkoff technique. The limitations imposed by such systems, during a dynamic situation, are obvious.

b. Roman, Henry and Meehan[1] attempted to measure direct arterial blood pressures during straight and level flight in the pilots of the NASA research NF-100F aircraft. Though able to obtain acceptable tape recorded arterial pressure curves, difficulty was encountered in three basic areas: (1) continuing baseline shifts which could not be readjusted during flight, (2) difficulty in placing the appropriate catheters and (3) difficulty in maintaining these catheters in a satisfactory condition during the flights.

c. It is possible to fabricate a stable transducer mounting system which can be placed into the NF-100F aircraft (back seat) in such a way as to assure subject comfort and at the same time not interfere with the pilot in aircraft emergency egress systems. These mountings have currently been completed with the background of existing class II modifications. The system outlines a standard Statham P23De transducer with an attached variable potentiometer to facilitate readjustments of the zero baseline while in flight. With this system, existing telemetering capability can be utilized for the recording and direct monitoring of direct blood pressure measurements in the aircraft in flight. The feasibility of such a system has been proved in test flights by the above authors.

b. The current routine clinical use of microcatheters has made measurements of intracardiac, great venous and arterial pressures not only routine but safe and relatively non-traumatic. The ease of maintenance of these catheters, even under highly dynamic circumstances, has been well demonstrated in instances too numerous to cite.

e. The advantage of a simple, direct system for measuring intravascular pressure changes during flight is apparent. It is only in this way that the physiologic changes imposed by the stresses of high speed, low level flight, acute weightlessness and high G loading be assessed relative to subject performance in the actual aircraft environment.

f. Hazards/Precautions:

a. The flight environment of the single engine jet fighter is, normally, a hazardous environment. However, adequate protective equipment and procedures are well established. The subject selection will include only those who have familiarity with and participate in flight in the F-100F aircraft.

b. Interference of the transducer mounting and connectors with the emergency egress systems of the aircraft constitute a potential hazard to flying safety. The mounting system used has been previously accepted under a Class II modification. The transducer and variable potentiometer connections are all of the "break away" variety and are compatible with the emergency egress systems. (See report of flying safety officer - enclosure)

c. The hazards related to subject instrumentation are not different than those routinely dealt with during blood sampling flights. The catheter placement is less traumatic. Forward motion within the great veins is prevented by individual fitting of the length of the teflon catheter to the subject in question. Positively secured catheter transducer - catheter connectors will be used in all cases in anticipation of eventual flights measuring pressures within the high pressure system. Unlike the blood sampling flights, or the previously cited studies of Roman et. al., direct M.D. monitoring from the ground based telemetry station will be routine. In the event of required emergency ejection from the aircraft, the subject is able to remove the catheter in less then 15-20 seconds.

d. An intermittent heparinized saline flush will be used, the total volume of the average not exceeding 60-90 cc of a 10 mg heparin to 1000 cc saline solution.

e. 2-3 cc of 60% Renografin ^{R} will be used to visualize the position of the catheter initially. Reactions with Renografin ^{R} are possible; however, the amount stated here is equivalent to the average intravenous test dose.

f. The radiation hazard of image intensification fluoroscopy is minimal. The current Keleket system in use has a well shielded beam with an operational level of approximately 1.0 ma and 65 Kv under average conditions. The time required to position the catheter is rarely in excess of 45-60 seconds.

8. Subject Requirements:

a. Five subjects will be required, all of whom have had flight experience in the NF-100F aircraft and most of whom will have participated in blood sampling flights. These latter subjects will thus have prior experience in the maintenance of intravenous catheters.

b. Total flight time will be of the order of 45 minutes to one hour per study.

c. Each subject will be used once.

9. Conduct of the Experiment:

a. After routine instrumentation with ECG electrodes, a fine teflon catheter previously measured to length will be inserted percutaneously into the right or left median basilic vein.

b. Under pressure monitoring through a Statham transducer the catheter will be advanced into the great veins of the thorax, opacified with 2-3 cc. of 60% Renografin, and the catheter tip identified. The tip will be positioned at the level of the right atrium-SVC junction.

c. ECG will be monitored through this procedure.

d. The catheter will then be secured to the skin and wrapped smoothly with an elastic bandage to minimize the possibility of inadvertent entanglement. In addition, the sleeve of the flight suit will be brought over the elastic bandage.

e. The subject will be accompanied to Kelly Air Force Base by an appropriate support individual and will be assisted in parachute fitting, positioning in the aircraft, etc.

f. The previously sterilized transducer system and mounting bar will be placed into the aircraft and, in conjunction with the monitoring station at SAM, balanced and calibrated.

g. The flight profile will consist of 4-5 zero-G parabolas performed at various levels of G loading. The subject will be continuously monitored through the telemetry system by the medical monitor who will have the full authority to terminate the study at his discretion.

4. Location of the Experiment:

a. Catheter positioning will be performed in the cardiac catheterization facility of building 170.

b. The F-100F flights will originate from KAFB in the usual fashion.

Bibliography

1. Roman, J., Henry, J. P., and Meehan, J. The Validity of Flight Blood Pressure Data. SAM-TR-65-27.

DEPARTMENT OF THE AIR FORCE
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Brooks Air Force Base, Texas 78241

Reply To
Attn Of: GPO

29 April 1968

Subject: Flying Safety Evaluation of Experimental Equipment

To: SMBD (Capt George N. Cohen)

1. This letter is to confirm the equipment proposed for blood pressure testing meets all safety requirements of this office.

2. The equipment holding bar has been approved for a previous experiment. Only very minor modification had to be made for this test. All transducer connections are of the break away type which will insure safe separation during emergency conditions. Close monitoring by the Flight Safety Section will continue throughout this testing.

ROBERT L. GROSHNER, Captain, USAF
Flying Safety Officer