Journal of Nursing and Occupational Health
JNOH, 2(2): 168-173
www.scitcentral.com

Review Article: Open Access

Practice of Aerospace Medicine in Field: A Comparison of Russian Air Force and Indian Air Force

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Received May 05th, 2020; Revised May 16th, 2020; Accepted May 18th, 2020

ABSTRACT

Introduction: Soviet Union is pioneer in Space and Aviation research. The first man in space was from former USSR. The two world wars and cold war era prompted development of two blocks in Aerospace Industry Simultaneously-Soviet bloc led by former USSR and Western block lead by USA. Traditionally, Soviet Union developed their Aerospace program in isolation and secretively, hence, there is paucity of scientific literature in the open source. Russia being a non-English speaking country, language also played an important role as a barrier in dissemination and sharing of knowledge with rest of the English-speaking world. The competitive and fast pace development of Aerospace Industry of these two blocks essentially meant development of Aerospace Medicine which was a natural outcome of the advances in the Aerospace Industry. The study of the application of principles of Aerospace Medicine in the field is likely to bring out the approach and rationale behind adopting certain measures to address various aeromedical issues.

Materials & Methods: The author interacted with aircrew and the base Aviation Medicine Specialist to understand the various aspects of application of principles of Aviation Medicine in a fighter base of Military Air Force of Russia (Russian Air Force) during a mutual interaction exercise between Russian and Indian Air Forces in the year 2014. The various aspects of Aerospace Medicine related to fighter flying viz Annual Medical Examination of Aircrew, Pre-flight medicals, Flying Clothing, Pre-flight meal, Long-duration flying and management of fatigue, Physiological training of Aircrew, Anthropometric Criteria for selection of Aircrew and Search and Rescue (SAR) facilities were observed and discussed at length.

Result: There was no major differences observed in the practice of aviation medicine in the field in Russian Federation Air Force and IAF.

Discussion: There were subtle differences observed in all the aspects of practice of aviation medicine in field and has been brought out in detail in the article. Due to language barrier, an interpreter was used to communicate during the interaction. The major limitation of this deliberation is that as the interpreter was from a non-aviation background, there is a possibility of misinterpretation or misunderstanding of certain facts.

Conclusion: The field application of Aerospace Medicine in Russian Air Force and IAF are similar except few differences. These differences are more due to the difference in medical doctrine and risk appetite rather than understanding of the aeromedical issue.

Keywords: Field Application, Aviation Medicine, Russian Air Force, IAF

INTRODUCTION

Indian Air Force (IAF) has been flying mixed fleet of aircraft procured from both Western and Russian sides. This implied that Aviation Medicine community of IAF had to study the aero-medical issues pertaining to both the systems in depth. The field application of the basic principles of Aviation Medicine to mitigate aero-medical issues due to design and challenges faced by these procurements of highly agile aircraft systems matured over the years with experience, dedicated research at the nodal centre of IAF i.e. Institute of Aerospace Medicine IAF and by imbibing the best practices followed world over. Despite the fact that IAF has been flying the maximum number of Aircraft of Russian origin, there was no air force to air force interaction. This meant that there was no sharing of experience between these two Air Forces flying the same Aircraft systems.

With the changing geo-political situation, Russia has now opened up and widened its scope to share their experience with India. The first ever Air force to Air force exercise

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Citation: Kumar A. (2021) Practice of Aerospace Medicine in Field: A Comparison of Russian Air Force and Indian Air Force. J Nurs Occup Health, 2(2): 168-173.

between India and Russia was conducted as Ex-AviaIndra 2014 in Russia during the period 25 Aug – 05 Sep 14 in which fighter, helicopter, SAGW crew of IAF along with one Aviation Medicine Splt and one officer from engineering branch and Russia took part. The selected members of IAF visited and stayed at the Russian Air base and interacted and flew with them sharing the same cockpit. The same was reciprocated by the Russian Air Force by sending its team to one of the premiere air bases of the IAF. This interaction was very significant as it opened up newer frontiers and opportunity to share their experiences with each other. This is considered essential for professional growth of the formidable air forces of the world.

The Aerospace Medicine Specialist (Ae Med Splt) of the Indian contingent stayed at the air base throughout the period of exercise. The Ae Med Splt interacted informally with the Aviation Medicine Splt of the fighter Air base during the entire period of exercise. Reliability of the information is fair as the interaction was mediated by a translator who didn't have much experience on medical and aviation terminology. The approach of the Russian counterpart was positive and was open to discuss any aero-medical issues brought out as per his experience and expertise.

The Ae Med Splt of the IAF contingent discussed various issues related to Aircrew health and Operational requirements with the Russian counterpart. This informal discussion was highly fruitful as it shed light on their understanding of the effect of various aviation stresses on Aircrew and Medical Doctrine evolved to counter- act that. The various observations on aeromedical issues are discussed in the succeeding paragraph.

MATERIALS & METHODS

The author interacted with aircrew and the base Aviation Medicine Specialist to understand the various aspects of application of principles of Aviation Medicine in a fighter base of Military Air Force of Russia (Russian Air Force) during a mutual interaction exercise between Russian and Indian Air Forces in the year 2014. The various aspects of Aerospace Medicine related to fighter flying viz Annual Medical Examination of Aircrew, Pre-flight medicals, Flying Clothing, Pre-flight meal, Long-duration flying and management of fatigue, Physiological training of Aircrew, Anthropometric Criteria for selection of Aircrew and Search and Rescue (SAR) facilities were observed and discussed at length. Author also reviewed documents available in the open source and compared above aspects in Russian Federation Air Force and Indian Air Force.

RESULTS

Medical infrastructure

A dedicated Medical component in the form of Station Medicare Centre (SMC) is integral part of all Air bases in the IAF. The SMC has been classified as small, medium and large based on the available bed strength which is authorized based on the dependent population of the base. The SMC operate as a small hospital with its entire component including Station Health Organization (SHO) for providing preventive health care. However, it is Out-Patient Department heavy system but also have in-patient facility for treatment of minor ailments at the base. The SMC is capable of holding casualties for up to 72 h during operations and primarily provide medical cover to all air operations of the base. The SMC is well supported by a dedicated chain of military secondary and tertiary care centres (Military Hospitals, Base Hospitals and Command Hospitals) along which patient is evacuated by road or air. All fighter bases have an Ae Med Spl to monitor aero-medical issues and provide solutions to aeromedical problems and dedicated health care to aircrew and their families. The SMC is also the centre of field research in Aerospace medicine at the air base.

The Medical infrastructure in Russian Air Force base comprised of a state polyclinic located close to base where military doctors work along with the state government doctors to look after the ex-servicemen and serving personnel of the concerned base. Families of the air force personnel including aircrew report to a nearest health care centre of the state. The state polyclinic of the fighter air base had 30 beds and 03 Air Force doctors while the state government had employed a Neurologist, ENT Splt, Ophthalmologist and Pathologist. All cases requiring further treatment and evaluation are referred to nearest state secondary/ tertiary care centers.

The Russian Air Base did not have a dedicated Medical set-up for their aircrew and dependent families but utilize the common state polyclinic which also looks after the local civilian population unlike in the IAF base where there is a dedicated medical set-up.

Medical support to flying operations

The flying Squadron was located in the ATC building itself. During flying one military doctor from the state polyclinic was made available in-Pre- flight medical room which was located at ATC to look after any aircraft emergency. Crash Ambulance parked in the ATC was manned by a duty nurse/ duty nursing assistant. Crash ambulance was geared up with portable oxygen system, a pneumatic patient carrier system and a stretcher.

Pre-flight medical (PFM) is done for all personnel involved in flying operations including ATC controller and Fighter controller unlike in IAF where PFM is done only for the Aircrew who is planned for the mission that day. PFM is done before the planned flying briefing for the day which is valid for 8 h for fighters and 10 h for transport and helicopters in Russian AF. In IAF, PFM done in the morning is valid till dusk for fighters and 24 h for the transport and

helicopters, however, a separate PFM for night flying is mandatory for fighter operations.

In Russian Air Base, Night flying is planned in such a way that it goes in continuation with day flying and hence, effectively PFM is done once. This is necessitated with the fact that Russian Air base did not have any accommodation for their personnel. They stayed in civilian areas and reported for work as per the planned flying program of the day. For convenience sake, peace time operations are planned in a way that Aircrew finishes the task in reasonable time frame of 8 h. The Squadron was well equipped with resting and recreation areas and Jacuzzi so that aircrew rest and recoup when needed.

PFM is individual's responsibility as in IAF. Aircrew report with their Annual Medical Examination (AME) certificate which they carry all the time in their breast-pocket. The Aircrew sign the attendance register kept in the Pre-flight medical room and then the doctor examines their pulse, Blood Pressure and axillary temperature. The accepted range for vital parameters is pulse less than 90 beats per min, BP in the range of 120/80 ± 20 mm of mercury and axillary temperature in the range of 35°C-37°C. The doctor asks few questions to ascertain they had adequate rest (min 8 h sleep), not under influence of alcohol (72 h abstinence from alcohol). The doctor quickly examine ear for Eustachian tube clearance. Any Aircrew with abnormal physiological parameters mentioned above is referred to polyclinic for further evaluation. However, in IAF PFM is a visual inspection done by the base Medical Officer during the flying briefing and aircrew signs an undertaking stating that he had adequate sleep for 8 h and has not consumed alcohol for last 12 h and he is not on any medication except approved by the medical board [1].

Annual medical examination of aircrew

In Russian AF, Medical Examination of aircrew (up to age 30 yrs) is done yearly at the Polyclinic. Aircrew of age more than 30 years have to go to Moscow Institute of Aviation Medicine once in 3 yrs (or other centers located in Russia). All medical boards and categorization for aircrew is done at the same institute. In IAF, AME is done by the base Ae Med Splt for all aircrew up to the rank of Group captain. Any aircrew who are declared unfit temporarily, get reviewed at one of the three medical evaluation centres of IAF v.i.z IAM IAF in Bangalore, AFCME in New Delhi and MEC (East) in Jorhat (Assam). All aircrew with muskulo-skeletal injuries get evaluated at IAM IAF only. Medical boards can be done at one of these three centers and at the air base as well. IAF has relaxed the requirements by empowering local Ae Med Splt to do the board and upgrade the Aircrew for many disabilities.

Russian Aircrew are required to carry the Annual Medical Examination certificate at all times which is checked during pre-flight medicals for currency of medical category. This is not in practice in IAF as the base MO or Ae Med Splt is fully aware of the medical status of their fellow aircrew unlike in Russian AF where military doctor on roster from local state Polyclinic come for the PFM. The date of last AME done and medical category has been incorporated in the pre-flight medical proforma in IAF which is signed by the aircrew during their PFM.

Russian Aircrew undergo intensive medical investigations which include hematological profile, biochemical profile, ECG with step test, CXR- PA, Lung function test, Dynamometry both upper and lower limbs. Once in three years Russian Aircrew undergo Ear Clearance Run and Centrifuge test for G- tolerance at the nearest Aviation Centre (it is clubbed with the physiological training required to be done once in 3 yrs). The IAF Aircrew undergoes basic hematological and urinalysis during routine Annual Medical Examination. For overweight and obese personnel, extensive biochemical test profile along with Chest X-ray, USG abdomen and Blood Sugar Fasting and PP is done. ECG is done every five years till the age of 30 Yrs and every year thereafter. TMT is done every five years after the age of forty [2].

Russian Air Force ground crews are examined annually at Polyclinic and only general physical examination and CXR-PA is done. Any other investigation is done based on clinical findings or complaint from the individual. All IAF ground crew is evaluated annually and managed for any disability at the base by taking treatment and opinion from the specialists of the secondary and tertiary care centers in their echelon. Medical board for any disability is conducted locally at the SMC for them.

Flying clothing

In Russian Air Force, the Aviation Medicine Splt of the base is overall responsible for maintenance and inspection of flying clothing worn by aircrew. He helps aircrew in selecting properly fitting G- suit, helmet and mask when issued. Technical personnel are working under him to maintain and test the flying clothing. Flying clothing is inspected and tested at a test chamber located at ATC (Squadron is located in the ATC building) once a month which is then certified by the Av Med Splt for its fitness for flying. Similar responsibility is assigned to the Ae Med Splt in IAF as well. However, responsibility of maintenance of flying clothing lies with the Squadron Tech Flt where a SEW tradesman maintains it. Monthly inspection is done by the base Ae Med Splt. All new flying clothing's received by the base are jointly inspected by the base Ae Med Spl and Station Aerospace Safety & Inspection Officer (SAS & IO) for any defect or fitness for use. There is no test bench available for assessing the working of the Flying clothing (Anti-G Suite or mask and regulator). However, they are tested on the aircraft itself by the Aircrew before every sortie.

In Russian Air Force, Anti- G suit (AGS) is worn by a fighter pilot only when mission planned involve exposure to +Gz of more than 4 +Gz. Routine flying where exposure to +Gz is not expected, AGS is not worn. This recommendation is as per the technical flying manual of the fighter aircraft, not a medical recommendation. However, all fighter aircraft sorties are flown while wearing AGS in IAF.

Pre-flight meal

Russian Air Force Aircrew is expected to have meals every 4 h. Pre- flight menu is prepared by a dietician under supervision of Av Med Splt of the base. Pre-flight menu is provided by an outsourced catering agency which runs the cafeteria. Pre-flight meal is provided to all personnel who are associated with flying activity including ATC officers, Fighter controller and technical staff. However, scale for pre-flight meal varies as per branch. However, pre-flight meal is authorized only to Aircrew in IAF who gets the meal prepared in aircrew cafeteria of the Squadron. The menu of the pre-flight meal is perused and monitored by Ae Med Splt of the base.

Long duration fighter flying and management of fatigue

Longest fighter mission flown by Russian Air Force is close to 8 h. Inflight meal is consumed in the form of paste provided in tubes. Interaction with the aircrew revealed that they were quite comfortable with this form of inflight meal. IAF has flown 6 h of fighter mission in the Russian fleet and the in-flight meal provided in tubes was not found palatable and acceptable to the Aircrew. Rolls and sandwiches are preferred as in-flight meal.

No pharmacological agent is permitted to be used for management of fatigue in Russian Air Force. IAF permits use of Tab Modafinil as 'Go- Pill' and Tab Zolpidem as 'No-go pill' under supervision of the base Ae Med Splt.

In Russian Air Force, Av Med Splt of the base monitors the psychological health of all aircrew. Clinical psychologists and counselors available in civil are utilized when deemed necessary. Av Med Splt maintains roster of leave taken by all aircrew. It is emphasized that aircrew should at least avail 45 days of leave in a year. Gap between two leave periods should not exceed more than a year. In IAF, the Ae Med Splt is available in the base round the clock and usually familiar with every aircrew which helps him in identifying any psychological issues affecting the aircrew. A professional counselor outsourced at the SMC of the IAF base is utilised if required. CO and Flight Commander of the Squadron seek help from the Ae Med Splt if any aircrew is identified with having psychological issue.

Physiological training of aircrew

All aircrew of Russian Air Force undergo comprehensive physiological trg at various centers located in Russia (viz Burdenko Central Military Hospital at Moscow, Institute of Aviation Medicine in St Petersburg) once in every three years. This is clubbed with the annual medical examination of the aircrew of age more than 30 yrs. This takes from ten days to 03 weeks to complete. All aircrew of IAF undergo five days physiological training in the form of Operation Training in Aerospace Medicine (OPTRAM) which includes extensive didactics on Spatial Disorientation (SD), physiological changes under high Gz environment and methods to mitigate them, physiological changes during hypoxia, ejection injuries, escape and survival, stress coping and physical conditioning along with practical demonstration on DISO trainer for SD, exposure to hypoxia and Ear Clearance Run at 1 and 2 Aeromedical Training Centres (AMTC) for transport and Helicopter Aircrew. Along with these, the fighter Aircrew undergoes High Performance Human Centrifuge training at IAM IAF.

Russian Air Force Aircrew Practice Anti- G Straining Manoeuvre (AGSM) which is slightly different from L1 and M1 manoeuvre in breathing component where they breathe in and out very fast after initially holding the breath. Muscle tensing component is reported to be the same. The IAF Aircrew practice L1 manoeuvre with 4 s cycle of AGSM.

The Passing criteria for G- level tolerance in the Physiological training for Russian Air Force Aircrew is 7 Gz for 30 s without AGS while performing AGSM for non-Air Superiority Fighters and for Air Superiority Fighters is 9 Gz for 30 s with AGS and AGSM. The passing criterion for G-level tolerance in OPTRAM is 9 Gz for 5 s for all aircrew in the IAF. In addition, they also undergo simulated Air Combat Manoeuvre training with continuous loops of 4 Gz x 10 s and 8 Gz x 10 s for endurance training of AGSM. The IAF aircrew is also exposed to 'the Push-pull effect' during OPTRAM. The IAF aircrew also needs to undergo refresher training every three years, however, it is not linked with their Annual Medical Examination but with Instrument Flight Rating.

Anthropometric criteria for selection of aircrew

In Russian Air Force, the Anthropometric criteria for selection of aircrew are three-fold viz Arm reach (>76 cm), Sitting height (80cm-97 cm) and Leg length (>80 cm). In IAF, the anthropometric criteria for selection of Aircrew is four-fold viz standing height (>162.5 cm), Sitting Height (81.5 cm–96 cm), Leg length (99 cm-120 cm) and Thigh length (<64 cm). Thigh Length is not included in the anthropometric selection criteria of Russian Air Force. There is no relaxation in anthropometric criteria as per age or sex in both the Air Forces.

Search and Rescue Operations (SAR)

Unified Command and Control Centre for SAR looks after the SAR requirement of Russian Air Force. A trained team of paratroopers is available onboard to extract the injured aircrew from the site of accident. In addition, one rotary wing aircraft is on standby at base to be used for SAR. Duty Medical Officer (DMO) is available on call and reports to

ATC on receipt of distress call to board the SAR Aircraft. There is no centralized command and control of SAR in IAF. One rotary wing aircraft is always available for SAR duties Whenever fighter flying is done. Whenever an aircraft emergency is declared, the Chief Operating Officer controls the SAR activities Along with SAS & IO of the base. The DMO of the base provide medical cover during such eventualities.

DISCUSSION

The Russian Air Force has traditionally been pioneering in aviation and space research and their medical doctrine evolved independent from west. IAF has been operating Aircraft procured from western fleet as well as Russian fleet. IAF is operating in myriad terrain with sudden change in topology and weather. The medical doctrine evolved over the years to meet the organizational goal of safe conduct of flying operations and retrieval of aircrew in distress at the earliest. The medical doctrine of IAF has been influenced by both western and Russian counterparts.

The dedicated medical services of the IAF serves it better as the families of the aircrew stay inside the base. The aircrew is tension free to know that there is a doctor who he knows well and available round the clock at the base to look after him and his family. This acts as a force multiplier. Besides, the adequate state medical infrastructure may not be available close to an air base as they are usually located in far-flung areas. The availability of the Ae Med Splt at the base also allows flexibility in planning of flying operations. The availability of the doctor at the base allow aircrew to interact with him socially and officially building a good rapport among them which eventually translate into better co-ordination of flying activities and early identification of any stressed-out aircrew. This personalized medical facility is a force multiplier for IAF.

IAF medical services conduct Annual Medical Examination for all personnel with the aim to identify any disease or disability early, to initiate treatment on time and bring back the crew back to work at the earliest. This is equally true for aircrew which is back- bone of all operations in IAF. Russia is plagued with Tuberculosis and smoking and hence, Chest X-ray is done annually to diagnose the disability early. IAF Aircrew stays in a clean and controlled Air base where spread of such communicable disease is uncommon. However, Chest X-ray is done once between the age of 40-45 years for everyone and once in five years for smokers. Conducting AME at the SMC for a healthy aircrew prevents man-hour loss to the IAF.

The pre-flight medical at IAF is done by a visual inspection by Ae Med Splt or the DMO of the base that knows the aircrew well and can identify any signs of fatigue or derangement. Further, aircrew himself signs the undertaking stating that he is fit and had taken adequate rest and has not consumed alcohol in last 12 h and is not on any medication other than approved by a medical board. This appears to be a good arrangement and has served IAF well. This also prevents man-hour loss due to clinical examination which is not reliable to identify fatigue or other stressors. However, the Ae Med Splt is at freedom to examine any aircrew during PFM if he suspects any ailment or distress.

The maintenance of flying clothing is the responsibility of Technical Flight (Tech Flt) in IAF whereas it is the responsibility of Aviation medicine splt of the base in Russian Air Force. The SEW works under Tech Flt and Ae Med Splt inspects the flying clothing at least once a month. He can declare any flying clothing unfit for use during such inspections. This arrangement has served well in IAF and appears to be more logical as technical expertise is available in the Tech Flt under the supervision of a Technical Officer.

The fighter flying is inherently at high-risk. There can be a situation in a normal fighter flying where pulling G was not planned that it lands into an uncommanded attitude from which if it is maneuvered to regain control (especially during tight turn) there might be significant +Gz build-up. The inflation of AGS at 1.4 G and above serves as a reminder for the aircrew to perform AGSM which he may miss out otherwise. The practice of wearing AGSM for all fighter flying is a deliberate and logical decision which has served IAF well.

The pre-flight meal is only provided to aircrew in IAF whereas all personnel involved in flying operations is provided pre-flight meal every four hour in Russian Air Force. The IAF envisage pre-flight meal as reserve for aircrew during survival situation apart from improving his physiological response under aviation stresses like +Gz. The provision of meal four hourly to all its personnel involved in safety critical operations appears to be logical and scientific. However, stress of work and changes in life-style has led to emergence of overweight and obesity as a new threat with which IAF is battling. Provision of meal four hourly may act as a double edge sword for the personnel other than aircrew.

IAF need to be prepared for short but intense war at all times due to the geo-political situation. The management of fatigue during such operations will be critical. The pharmacological management of fatigue will give an edge to the aircrew during such scenario. IAF has approved usage of 'Go-pill and No-go pill' for specific situations only under the supervision of Ae Med Splt of the base and consent of the aircrew. This is in consonance with western world which has been using these drugs for management of fatigue. The usage of these drugs has been approved after extensive research at IAM IAF. The acceptance of these drugs by aircrew during operations has shown encouraging results.

The physiological training of IAF aircrew in the form of OPTRAM is at par with NATO guidelines and has been certified by USAF as well. The five days comprehensive course covers all aspects of aeromedical issues and exposes aircrew to the stress of Hypoxia and gives high G training in

HPHC. Earlier, IAF also had a separate passing criterion for non-ASF and ASF aircrew. However, the change in medical doctrine led to single criteria for all fighter aircrew. This has an advantage of preparing the aircrew for worse situation and also allows change of fleet when needed without waiting for OPTRAM. The passing criteria of 9 +Gz for 30 secs appear to be extreme for ASF fighter in Russian Air Force. The passing criterion of 9 +Gz for five secs have served IAF well and is well accepted in aviation community.

The anthropometric criteria for selection of aircrew are dictated by the trainer aircraft. The anthropometric criteria are based on the HPT-32 (Deepak), HJT-16 (Kiran) and Mig 21 – Type 66. The thigh length of 64 cms was a limitation due to Mig-21 (Type-66). Presently, the basic trainer aircraft in IAF has changed to Pilatus now and Advance trainer is HJT-16 and Hawk. Hawk has limitation of thigh length of 63 cms and additional Functional arm reach of minimum 72 cm. Further, it can only support weight ranges from 56.5 to 97.3 kgs. The anthropometric limitations are under review at IAF.

CONCLUSION

The field application of Aerospace Medicine in Russian Air Force and IAF are similar except few differences. These differences are more due to the difference in medical doctrine and risk appetite rather than understanding of the aeromedical issue. There is a scope for widening of this interaction for mutual benefit.

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