PARADIGM CHANGES IN AEROMEDICAL SUPPORT FOR THE REPUBLIC OF SINGAPORE AIR FORCE

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ABSTRACT

Since the advent of the first powered aircraft, aircraft performance has progressed phenomenally, exposing aircrew to a variety of physiological and cognitive challenges. New aeromedical concepts and protocols have been developed and applied to overcome physiological limitations in the human operator. In this article, the authors cover the evolution of aeromedical support capabilities in the Republic of Singapore Air Force (RSAF) in tandem with the advent of military technology and the introduction of new generation fighter aircraft and weapon systems. Next, will be a description of the importance of aircrew training, which has contributed significantly to improvements in flight safety and mission effectiveness. Looking ahead, the authors feel that the future air warfare concepts and platforms of tomorrow will increasingly extend the physiological and cognitive limits of our operators. To this end, the RSAF needs to focus on developing new approaches to maximise human performance, redefine conventional human limits and enable the airman to lead the sharp edge of our air warfare capabilities.

INTRODUCTION

Aviation is a relatively recent phenomenon, only taking off significantly since the early 20th century. Soon after the advent of the first powered aircraft, several nations started exploring the utilisation of aviation for purposes of military operations. This created the need to set medical standards for aircrew, and heralded the birth of military Aviation Medicine. The Germans were among the first to develop a minimal set of aeromedical standards in 1910, and this was soon followed by the Italians, British, French and Americans, as the flying units recognised the importance of medical standards for pilots as a significant factor affecting flight safety. By 1918, all the major powers had medical services dedicated to aviation.¹

In the subsequent decades that followed, aircraft performance continued to increase at a phenomenal rate, with the ability to fly faster, higher and for longer durations. As aviation developed, it was quickly realised that it exposed aircrew to a variety of environmental conditions that the human body had no natural ability to withstand. These advancements placed additional physiological stressors on the aircrew, such as intense acceleration forces, rapid pressure changes, inadequate oxygen at altitude, and dizzying disturbances to spatial orientation. This spurred the need to grow research, development and training in the realm of flight physiology, and to have life support systems to enable the aviator to operate effectively and safely in the aircraft.
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In Singapore, the foundation of Aviation Medicine was laid with the formation of the then-Singapore Air Defence Command (SADC) in 1968. The first medical centre supporting the SADC in catering to the unique medical requirements of military aircrew and air traffic controllers was set up in Seletar West Camp in the same year. However, it was already acknowledged that general medical training alone would not provide Medical Officers in our fledgling air force with the ability to optimise the health of our military aircrew, much less maximise their performance in the unforgiving flight environment.

By the early 1970s, the RSAF had progressed from a few Cessna 172Ks to operating the A-4 Skyhawk jet fighters, and there was a need to enhance pilot safety and effectiveness in flying these high-performance jets. The few military doctors in service at the time were successively sent to the Royal Air Force Institute of Aviation Medicine in the United Kingdom for specialist training in Aviation Medicine. In 1982, the RSAF Aeromedical Centre (ARMC) was developed as a specialist centre for aeromedical services and physiology training under one roof. The centralisation and consolidation of aeromedical expertise propelled the development of Aviation Physiology Training programmes for aircrew. It also provided the platform for the expansion of the breadth and depth of other aeromedical capabilities such as medical and psychological screening and selection, research into performance maximisation, and the conduct of aeromedical evacuations.

AVIATION PHYSIOLOGY TRAINING (APT)

Aviation Physiology Training is one of the cornerstones of flight safety in modern day air forces. It aims to train aircrew in the physical and mental effects that they may experience during flight and in so doing, protect them from the potential pitfalls and hazards. A multitude of studies and reports have consistently documented the importance of APT in minimising aviation incidents and accidents, and this section of the article will use two examples to detail how it has been critical in ensuring the safety of our aircrew and supporting the RSAF’s mission success.
Hypoxia Training

Hypobaric hypoxia, or the lack of oxygen due to exposure to reduced barometric pressures at altitude, is generally recognised to be the single most serious physiological hazard during flight. Depending on the exposure altitude, symptoms can range from a mild impairment of the pilot’s mental performance to rapid incapacitation and death. To make things worse, this can occur insidiously, with the pilot being unaware of the onset and progress of impairment, and aviation history is full of examples of the resultant loss of lives and aircraft. A retrospective study was previously done in the Australian Defence Force, analysing aircraft safety occurrence reports between 1990 and 2001 listing hypoxia as a factor. The study found that 75.8% of these hypoxic episodes were recognised by the aircrew themselves due to prior hypoxia training, thereby enabling them to take corrective measures and avert any potentially fatal accidents. In the RSAF, aircrew undergo hypoxia training since 1986, to replicate the effects of exposure to high altitudes. This gives them the opportunity to gain personal experience of hypoxia under controlled conditions, and helps them recognise its onset should it occur during flight. This year, the hypobaric chamber will be upgraded to allow the expansion of, and further improve the fidelity of training.

Human Training Centrifuge

G-induced loss of consciousness (G-LOC) has also been recognised as a significant physiological hazard in military flying, especially in fighter aircraft, with anecdotal reports of G-LOC dating back to before 1920. Internationally, air forces have periodically lost pilots and aircraft to G-LOC, with a recent example being the fatal crash of a UK
Royal Air Force Red Arrows aerobatic display aircraft in August, 2011. With the transition to newer generation fighters with enhanced performance and manoeuvrability, fast jet aircrew are exposed to greater acceleration forces and a higher risk of G-LOC. High-G training aims to prevent such incidents by allowing pilots to hone, in a controlled environment, their anti-G straining manoeuvre, a skill crucial to prevent G-LOC and ensure survivability of both man and machine during air combat. In the RSAF, the first operational High-G training was conducted on 9th March, 1995 and we have never looked back since. Today, high-G training is universally recognised as an essential component of a fighter pilot’s core training. This is validated by the studies such as the one conducted by the United States Air Force, which demonstrated a reduction in G-LOC crashes from 4.4 per million flight sorties to 1.6 after the implementation of anti-G-LOC training programmes in 1985, underscoring the importance of such training in enhancing crew safety.4

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**CORNEAL REFRACTIVE SURGERY PROGRAMME**

As a small country, Singapore has a very small human resource pool from which to select its military aircrew, and this is set to worsen due to the country’s low birth rate. This situation is exacerbated by the high prevalence of myopia, which can disqualify otherwise-suitable candidates. This has been a cause of concern for the RSAF, with the need to maintain high visual standards as a selection criterion conflicting with the requirement of recruiting sufficient
aircrew. A study of RSAF pilot applicants who underwent medical selection examination over an eight-year period from 1984 to 1991 found that 19.8% of them were unable to meet eye refraction standards. Despite a subsequent relaxation of spherical error limits by -0.50 D, the proportion of RSAF pilot applicants over the eight-year period from 1999 to 2006 who were medically disqualified due to refractive errors remained high at 11.7%

The RSAF introduced the Corneal Refractive Surgery (CRS) programme in 2005, with the aim of enlarging the recruitment pool of potential military aviators. Pilot applicants whose myopia fell within permissible limits were enrolled into the programme, and would undergo photorefractive keratectomy (PRK) surgery to correct their refractive errors. A study was done reviewing the results in 149 eyes of 76 RSAF pilot applicants that underwent PRK over the five-year period from 1st January, 2006 to 31st December, 2010. The study found that 12 months after surgery, 98.5% and 100.0% of eyes had achieved Uncorrected Visual Acuity of 6/6 or better and 6/12 or better, respectively, with a low rate of complications. The introduction of CRS to mitigate the high prevalence of myopia in our local population is a game-changer in overcoming the manpower resource constraints for the RSAF. Since then, the RSAF has further expanded the scope of CRS to allow higher myopes into the programme, as well as include the modality of Laser Assisted In-situ Keratomileusis (LASIK) to further enlarge the talent pool available for recruitment.

**PERFORMANCE MAXIMISATION**

Operational demands may at times require aircrew to fly for long hours across multiple time zones, resulting in issues related to jet-lag, poor sleep and resultant aircrew fatigue. Such fatigue must be recognised as a threat to aviation safety, as the evidence is clear that sleep deprivation has deleterious effects on attention, reaction time, and cognitive ability. The build-up of aeromedical expertise in the RSAF has enabled us to develop and implement operational crew performance programmes in areas such as fatigue management and cognitive enhancement. Today, both preventive and interventional strategies are effectively paired to extend the endurance of the human envelope and peak the operator performance. An example is in fatigue management, where medications like modafinil and caffeine are coupled with active crew scheduling to overcome the physiological effects of extended operations and night missions.

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**OPERATIONAL SEARCH & RESCUE AND AEROMEDICAL EVACUATION**

In the operational realm, the RSAF has developed strategic Heli-medevac and Aeromedical Evacuation (AME) capabilities to evacuate casualties back to our local hospitals. Since 2002, we have progressively built up the intensive care capabilities that will be delivered in both our helicopter platform (for Heli-medevac) and transport aircraft (for AME). This includes upskilling and training our
medical personnel—both active and NSmen—as well as equipping the flight medical teams with state-of-the-art equipment for casualty monitoring, resuscitation and treatment. As strategic capabilities, both Heli-medevac and AME fulfil important roles for not only the SAF but also Singapore.

The ability to launch Search and Rescue (SAR) missions within minutes by the RSAF engenders confidence in our soldiers and commanders in both training and operations. Equally essential, the extension of this capability to serve civilian casualties in the Singapore Flight Information Region (FIR) directly supports our national interests and is a vital resource for Singapore.

The SAF trains in many parts of the world. On occasion, the RSAF has been called upon to bring back SAF personnel who are unwell or have suffered injuries overseas. To this end, AME is vital to facilitate the transfer of these personnel to a higher echelon of medical care, or even repatriate them to Singapore should the need arise. Air Force Medical Service has conducted more than 30 AME missions since 1985, and evacuated more than 80 patients. This capability has allowed our soldiers, airmen and sailors to train and execute their missions beyond Singapore’s shores, with the firm assurance of timely access to advanced military medical care.

LOOKING AHEAD – AEROMEDICAL SUPPORT IN THE FUTURE

The next bound of aeromedical support for our air force will be shaped by the evolving texture of modern and future air warfare, as well as the rapid advancement of military aviation technology. For instance, the progress toward the fifth-generation fighter jets will pose new challenges to its aircrew. Besides the physiological challenges (e.g. G-forces) that...
accompany faster and more manoeuvrable aircraft, aircrew will also be placed under increased cognitive loads. With improved avionics systems and advanced technologies, newer aircraft will have excellent capabilities for information acquisition, but the aircrew will be required to assimilate and make sense of the information, in order to make a decision within seconds to maximise the success for the prosecution of the mission. New and novel ways of training will be required to enable the aircrew to effectively manage data from multiple sources, prevent cognitive overload, sense-make and utilise the information effectively in the heat of the mission.

Another expected major change will be the increased utilisation of Unmanned Aerial Vehicles (UAVs), with Air Forces around the world moving towards unmanned platforms. UAVs are currently being utilised for many purposes, for example reconnaissance, and has much potential for expanded roles. This will pose unique challenges to the UAV pilots. Moreover, studies of UAV pilots in other Air Forces have revealed that although they are not at risk of physical injury, the nature of their work renders them prone to psychological issues such as emotional distress and Post-Traumatic Stress Disorder.10

Developments in the geopolitical landscape, conventional and non-conventional threats, and new and emerging aviation technological capabilities will all contribute to shape the mission of the RSAF in the future. Aeromedical support to our airmen and the Air Force must be pre-emptive, responsive and adaptive to address the challenges to come. To this end, tight ops-medical integration will ensure that paradigm changes in the development of our aeromedical capabilities of the future remain relevant, timely and key to mission success.

ENDNOTES


