Aerospace Medicine at King's College London

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This year's President's Pages have periodically focused on different Aerospace Medical Research facilities worldwide. This month includes a very excellent submission from **Dr. Thomas Smith**, Head of Aerospace Medicine Research, Centre for Human and Applied Physiological Sciences, King's College London.

History and Overview of Aerospace Medicine at King's College London

King's College London is one of the largest and most successful centres for biomedical research and education worldwide. King's is one of the top 10 universities in Europe and ranked 31st in the world (QS University Rankings 2021). King's was founded in 1829 and its oldest teaching hospital (St. Thomas' Hospital) was founded about 900 years ago.

King's has held a unique position as an academic centre for aerospace medicine in the UK for decades. Combining research, education, and clinical practice in aerospace medicine, this long heritage grew out of an enduring partnership with the Royal Air Force (RAF) that remains just as strong today.

King's is perhaps best known within the specialty for the flagship Diploma in Aerospace Medicine. This intensive course is run in collaboration with the RAF Centre of Aviation Medicine and also prepares doctors for the Diploma in Aviation Medicine (Royal College of Physicians) which has been respected worldwide for over 50 years. The late Professor John Ernsting led the course at King's for many years from the 1990s and his standard reference textbook, "Ernsting's Aviation and Space Medicine", is now edited by another King's Professor of Aerospace Medicine and current President-Elect of the International Academy of Aviation and Space Medicine (IAASM), Emeritus Professor David Gradwell. King's professors have made leading contributions to the specialty over many years, including as Presidents of AsMA (Mike Bagshaw and David Gradwell) and IAASM (John Ernsting and Tony Batchelor).

In addition to the RAF, longstanding collaborations with the UK Civil Aviation Authority (CAA) and ESA's European Astronaut Centre enrich multiple courses at King's. Doctors can extend their diploma studies to take a master's degree and Ph.D. students are jointly supervised with collaborators and industry partners. King's delivers Aeromedical Examiner (AME) short courses in conjunction with the CAA and also runs a renowned M.Sc. in Human and Applied Physiology that incorporates a significant component of aerospace physiology. Clinically, King's staff are experienced in military and civil aerospace medicine, AME practice and aeromedical critical care, and lead an aviation medicine clinic embedded with our hospital partner, Guy's and St. Thomas' NHS Foundation Trust. King's faculty were instrumental in achieving recognition of Aviation and Space Medicine as a UK specialty in 2016.

Overview of Aerospace Medicine Research at King's College London

The Aerospace Medicine and Physiology Research Group is part of the Centre for Human and Applied Physiological Sciences (CHAPS) within the Faculty of Life Sciences and Medicine at King's. CHAPS has a combined normobaric hypoxia/thermal chamber and the capability to undertake advanced *in vivo* physiological measurements including invasive respiratory techniques, neuromuscular testing and muscle physiology, cardiopulmonary exercise testing, and biomechanics. Research ranges from stem cell biology to systemic physiology and translational medicine across four research groupings:

- Aerospace medicine and physiology;
- Respiratory medicine and physiology;
- Muscle form and function; and
- Movement, function, and behavior.

The Aerospace Medicine and Physiology Research Group is made up of human physiologists and doctors from various specialties, including aerospace medicine, anaesthesiology, and respiratory medicine. The Group's mission is to advance the science of aerospace medicine and physiology and thereby optimize health and performance in aviation and spaceflight, with a vision to be a pre-eminent academic center of excellence in aerospace medicine and physiology. The Group's goals are to:

- Perform world-class research addressing important scientific and operational research questions;
- Optimize the safety and health of passengers and crew during air and space travel;
- Exploit novel translational research opportunities offered by aerospace environments to advance mainstream healthcare and clinical medicine;
- Support the development of air and space vehicles and associated life support and protection systems;
- Be the academic partner of choice in aerospace medicine for the military and commercial industry.

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Recent Research

Members of the Aerospace Medicine and Physiology Research Group collaborate widely with other UK and international universities, the military, airlines, space agencies, and commercial industry. Group members' experience includes hypoxia/altitude studies across a wide range of normobaric and hypobaric chambers and facilities, high altitude field work in the mountains, decompression sickness, thermal stress, research on commercial airline flights and general aviation flights, microgravity studies on parabolic flights, high G centrifuge studies, test and evaluation of aircraft life support systems, and human systems integration.

Recent work by members of the group has:

- Shown that acceleration atelectasis can occur with shorter/cumulative bouts of G_z and at lower inspired oxygen concentrations than previously thought;
- Discovered that hypoxic pulmonary vasoconstriction is stimulated by mild cabin hypoxia during commercial air travel and is more intense in older individuals, potentially contributing to in-flight medical emergencies;
- Established that high G relevant to commercial suborbital spaceflight launch/re-entry causes profound disruption of respiratory physiology, necessitating preflight centrifuge-based evaluation of potentially susceptible passengers;
- Identified neck muscle loads associated with different activities, helmets, and head mounted equipment for fighter pilots using musculoskeletal modelling and centrifuge trials;
- Evaluated G-LOC within the RAF and helped develop a new aircrew conditioning program targeted at improving G tolerance and reducing fatigue and neck injuries that is now used by military services in several countries;
- Established which RAF anti-G system provides the best protection for fighter pilots;
- Explored the use of in-flight physiological monitoring in military aircrew;
- Investigated the utility of monitoring tissue oxygen saturation in microgravity on parabolic flights in collaboration with NASA;
- Undertaken exercise efficacy studies with a novel gravity loading countermeasures skinsuit which was subsequently flown and worn on ISS;
- Developed a new microgravity analogue (hyper-buoyancy floatation) and used this to study total muscle loss and spinal extension under whole body unloading conditions;
- Investigated mechanisms underlying muscle loss in collaboration with NASA Genelab using multi-omics approaches;
- Conducted experiments on ISS astronauts as part of the Sarcolab muscle-wasting study;
- Developed a new method for performing CPR in hypogravity environments;
- Flown 32 school children's experiments on ISS through an international outreach program working with the International Space School Educational Trust;
- Advised on decompression sickness risk in high-altitude parachuting resulting in a new RAF policy on pre-oxygenation requirements for high-altitude parachuting; and
- Contributed to NATO policy and practice on white matter hyperintensities (on brain scans) associated with exposure to hypobaric environments.

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