

Late 1930s-Mid-1940s: Secret research transforms aviation

Amid the gathering storm of World War II, it was clear that aviation would play a key role in the coming conflict.

Yet while planes were greatly improved from the First World War, human physiology had not adapted to new conditions of flight. Pilots and crews were losing consciousness and crashing due to two problems:

- “Oxygen want” caused blackout due to a lack of oxygen at high altitudes.
- “G” (for “gravitational”) forces brought the equivalent of hundreds of pounds of weight against the body during sharp maneuvers at high speeds, preventing blood from circulating to the brain.

Whichever side could solve these problems would have a decisive advantage. The use of air power in the Nazi German blitzkrieg invasions of Europe and the Japanese attack on Pearl Harbor left no doubt of the high stakes involved.

Fortunately, Mayo Clinic had been exploring related topics for several years. As early as 1918, Mayo specialists began focusing on metabolism and the administration of oxygen in medicine.

In 1938, a Mayo Clinic team developed a high-altitude oxygen mask. It was called the BLB Mask for its inventors, Drs. Walter Boothby, Randolph Lovelace and Arthur Bulbulian. A crew tested the BLB Mask on a cross-country civilian flight, reaching record altitudes and arriving safely with no issues of oxygen want.

Progress in aviation medicine assumed far greater urgency when the United States entered World War II. As part of its contributions to the war effort, Mayo Clinic established the Mayo Aero-Medical Unit, which conducted much of its work in conditions of secrecy. The unit developed two highly innovative methods of research:

- To study oxygen want and altitude decompression sickness from parachute jumps, the unit established the first civilian low-pressure chamber in the country, engaging the collaboration of famed aviator Charles Lindbergh.
- To study the G forces that occurred in thrusting maneuvers of aerial combat, the Mayo Aero-Medical Unit built the first human centrifuge in the United States. Volunteer subjects strapped themselves into a simulated cockpit of a device that spun until they blacked out, enabling Mayo Clinic scientists to compile extensive data on how gravitational forces affect blood flow to the brain. During the war, more than 300 subjects – including the physicians and scientists who led the research project – took about 10,000 experimental rides in the centrifuge.

From these and other studies, Mayo Clinic made pioneering innovations:

- Straining maneuver – Known as “the Grunt” or M-1 (for “Mayo-1”) this action is a voluntary contraction in which an aviator increases pressure in his or her arms, legs, chest and abdomen, forcing blood to the brain so as to retain consciousness. The maneuver is still a mainstay of aviation training.
- The G-Suit – This full-body uniform has chambers that, when inflated with air, counteract G forces by directing blood flow to the brain. Willy Messerschmitt, the leading German designer of fighter planes, saw a G-Suit on a downed American airman and concluded: “We had nothing to match it, and I knew, if American aviation science was so far ahead of us to make such a suit, Germany had lost the war already.” Mayo Clinic researchers also developed a valve that connected the G-Suit to the plane’s air pressure system, ensuring automatic, continuous inflation of the suit.
- A-14 Mask – This was a wartime enhancement of the original BLB Mask. It automatically provided the pilot with as much supplemental oxygen as was needed.
- Bailout Bottle – Used by pilots and crews as they made parachute jumps from planes at high altitudes, this portable bottle ensured a supply of oxygen to help aviators remain conscious during descent, greatly increasing their odds of a safe landing.

By working closely with the military and civilian industry, Mayo Clinic’s discoveries entered mass production and combat use by American fighting forces in record time. Mayo’s aero-medical innovations also led to important post-war advances in catheterization of the heart, studies of lung function, military and civilian jet aviation and the space program. Mayo Clinic’s wartime services were valued at more than \$200 million, and the ultimate value of such wide-ranging discoveries is beyond calculation. For its services in World War II, the Mayo Aero-Medical Unit charged the U.S. government a total of \$1 per year.

SOURCES

1. “World War II and Mayo.” Nelson, Clark. Mayo Clinic Proceedings: November 1992; volume 67, number 11, page 1022.
2. [“Reaching New Heights: Secrets of the Mayo Clinic Aero-Medical Unit.”](#) Mayo Clinic Heritage Films.