



USAMRDC USAARL

U.S. ARMY AEROMEDICAL RESEARCH LABORATORY

MISSION

To deliver scientific solutions that save lives and increase performance of Army aviators, airborne Soldiers, and ground Warriors.

BACKGROUND

The USAARL, located at Fort Rucker, Alabama, is a nationally recognized laboratory for research into safety, survival, impact tolerance, sustainability and performance effectiveness of aviators and Soldiers. The USAARL's research focuses on blunt, blast and accelerative injury and protection; crew survival in military helicopters and combat vehicles; the en route care environment; human operator health and performance in complex systems and sensory performance, injury and protection. Current USAARL work for the Army's modernization priorities includes research in the areas of future vertical lift, the next generation combat vehicle and directed-energy weapons.

Laboratory personnel seek to improve force effectiveness by preventing or minimizing health hazards created by military systems, doctrine and tactics. Specifically, USAARL researchers identify, investigate and solve medical- and health-related problems that deter aviators and Soldiers from performing their missions or compromise their safety. The USAARL's top priority is providing information and

expertise to military developers to enhance the performance and safety of future Army systems, with research currently being conducted in the developments of future vertical lift and the next generation combat vehicle. Laboratory staff are evaluating enhanced cognitive and sensory function, fatigue countermeasures, optimal task management and the prevention, identification and mitigation of degraded states in future vertical lift operators. The laboratory's combat casualty care work is an asset for the development of the next generation combat vehicle, from medical interior and patient protection to operator and provider performance.

The laboratory conducts helmet impact testing, helmet retention testing and measurement of mass distribution properties of protective helmets. Additionally, due to the prevalence and attention to traumatic brain injury, the DOD has placed a priority on the development of sensor technologies to detect and quantify exposure to blunt and blast events in both combat and training. The USAARL is a leader in assessing and addressing these critical topics that affect Soldier protection against occupational and combat injury.



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For many years, the USAARL has evaluated the ophthalmic characteristics of eye protection and provided recommendations to industry and project managers to ensure that the eye protection worn by Soldiers meets military requirements and successfully protects from eye injury threats. To further the Army's competency in vision performance, researchers at USAARL have developed a surrogate human eye model, which aims to bridge the research gap between animal tissue and computer simulations of the eye, and an enhanced contrast sensitivity vision tester, which tests an individual's ability to detect objects along a continuum of lighting conditions ranging from extreme dim (night) to overwhelming bright (snow blindness) environments. Vision researchers are also investigating the impact of nutritional interventions and dietary supplementation of the macular pigment on visual tasks such as visibility through haze, low contrast target detection, contrast sensitivity, glare resistance and recovery, dark adaptation and mesopic sensitivity. These developments will advance the evaluation of injury/recovery, disability, surgery, and disease.

Exposure to intense noise and blasts in the military environment can cause damage to the peripheral auditory system and lead to tinnitus, dizziness and central auditory processing disorders. Soldiers' combat effectiveness and day-to-day functioning may be impaired because of these injuries. The USAARL research focuses on preventing the auditory effects of intense continuous and impulse noise and on addressing the concerns related to immediate return-to-duty. Additionally, the USAARL studies the ability of a Soldier to process numerous sources of auditory information in order to mitigate cognitive overload and a related degradation in performance.

Since 1959, the USAARL has served the aviation community by providing excellent aeromedical research aboard the laboratory's JUH-60A Black Hawk helicopter and inside its NUH-60FS Black Hawk flight simulator. Both devices

are capable of collecting pilot flight performance and pilot physiological/psychological data.

The laboratory assesses protective equipment involved in the DOD, U.S. Coast Guard and other federal government rotary-wing accidents to determine if the equipment functioned as designed and intended. Data are used to justify or recommend advancements in protection requirements for future aviation systems. This proven strategy is also employed with ground accidents to improve protection of military vehicle occupants as well as dismounted Soldiers.

The USAARL is the leader in testing and evaluating the efficacy of medical systems used in the U.S. military medical evacuation and ground transport environments, ensuring the safe interaction among the vehicle, medical systems, care providers and patients. Medical systems that meet military and industry fixed- and rotary-wing aircraft standards are eligible for an airworthiness release and may be safely operated onboard all U.S. Army aircrafts.

the areas of STEM and is structured to increase students' interest in these areas by engaging them in experiments. College-aged mentors teach GEMS participants fun, hands-on experiments. The laboratory also champions the coordination of Army-sponsored Camp Invention programs in a couple of local school systems. In addition to these efforts, the USAARL researchers open their laboratories to tour groups from area schools and USAARL personnel conduct outreach to Fort Rucker organizations and other local partners.

The USAARL's Science Information Center Library specializes in the field of aviation medicine. The library houses a large collection of aviation medicine, scientific and engineering publications. These include books, periodicals, technical reports and electronic materials.



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The USAARL plays an active role in science, technology, engineering and mathematics education outreach. Through a partnership with the Department of Energy, college students, post-graduates, faculty and established scientists can participate in Oak Ridge Institute for Science and Education, an educational STEM research participation program operated by Oak Ridge Associated Universities. The ORISE participants gain research and professional experience under the mentorship of USAARL scientists and engineers. In addition to ORISE, the USAARL leads the Gains in the Education of Mathematics and Science program at Fort Rucker each summer. The GEMS program is a U.S. Army Educational Outreach Program that emphasizes educating students in the areas of STEM and is structured to increase students' interest in these areas by engaging them in experiments. College-aged mentors teach GEMS participants fun, hands-on experiments. The laboratory also champions the coordination of Army-sponsored Camp Invention programs in a couple of local school systems. In addition to these efforts, the USAARL researchers open their laboratories to tour groups from area schools and USAARL personnel conduct outreach to Fort Rucker organizations and other local partners.

QUESTIONS & ANSWERS

How does the USAARL impact Soldiers' return-to-duty?

The USAARL's return-to-duty research program focused on assessing the impact of injuries to neurosensory systems: vision, hearing, balance and the central nervous system. This research program established valid, evidence-based, operationally specific return-to-duty criteria to determine the level of operational competence and performance of a Soldier after cognitive and neurosensory injury, including those resulting from blast, blunt and ballistic threats. Because of this research, the USAARL acquired a Technical Transition Agreement with both the Defense and Veterans Brain Injury Center and the Defense Centers of Excellence for Psychological Health and Traumatic Brain Injury to provide a Return-to-Duty Toolkit designed for use following neurosensory

injury. The toolkit provides the tools for clinicians to make better-informed decisions concerning the retention and possible reclassification of Wounded Warriors, and a more capable fighting force.

Who funds USAARL research?

The USAARL receives core funding from the U.S. Army Medical Research and Materiel Command Military Operational Medicine Research Program. Researchers also compete for and, if selected, are awarded funding through extramural funding opportunities, such as the Defense Health Program. Additional sources of funding include research partnerships with academic institutions, foundations, industry, and other DOD organizations.

Who are USAARL's research collaborators?

The USAARL collaborates with universities, foundations, industry, VA and military hospitals and other military laboratories.

What educational opportunities are available at the USAARL?

The USAARL offers internships through the ORISE program and the GEMS summer program.

- The ORISE program offers college students, recent graduates, faculty, and established scientists with research experiences in their respective field of study.
- The GEMS program allows college students to teach to school-age students hands-on science, technology, engineering and mathematics experiments.



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QUESTIONS & ANSWERS

What are some of USAARL's unique research capabilities?

The USAARL maintains the following research capabilities:

- Acoustics Research Facility includes anechoic and reverberation chambers, an audiometric research facility with a real-ear attenuation measurement room (in compliance with the ANSI standards), and a neuro-otologic rotary chair.
- Aeromedical Equipment Test & Evaluation Facility consists of an electromagnetic interference chamber, an altitude and a rapid decompression chamber, seven environmental chambers (heat/cold, dust, sand, rain, settling dust), two vibration tables, and two material testing apparatuses.
- Aviation Life Support Equipment Retrieval Program and Joint Trauma Analysis and Prevention of Injury in Combat Program aim to improve the protection of military aircrew via aviation and vehicle mishap investigations and system analyses.
- Biodynamics Research Facility houses a vertical acceleration tower, a shock tube and two projectile launchers, as well as dedicated workspaces supporting biodynamic instrumentation, biological specimens and test dummies for research focused in occupant survivability injury mitigation and protection criteria. Plans are in the works to enhance this facility with the addition of a horizontal acceleration sled.
- Biodynamic Data Resource is a data repository consisting of impact acceleration exposures, which resulted in volumes of kinematic and physiological data that serve as a foundation for historic and future injury biomechanics research, model validation and biofidelity requirements.
- Engagement Skills Trainer is a simulated small arms range used to conduct research on Soldier performance in static and dynamic marksmanship. It applies a unique in-house software program that transforms the data into more research applications allowing for the critical analysis of return-to-duty assessments and performance of Service Members under operational stressors.
- Helmet Impact and Retention Testing Facility includes a monorail impact tower, a free-fall impact tower, a mass properties instrument, a high-speed camera system, a dynamic mini-sled system, a Tinius Olsen quasi-static test machine and an Instron quasi-static materials tester.
- JUH-60A Black Hawk Helicopter is instrumented with in-flight measurement systems to monitor and record aviator physiological and cognitive status, flight performance and aircraft performance in real time.
- Man-Rated Multi-Axis Ride Simulator reproduces the ride of virtually any tracked/wheeled vehicle or aircraft, and is linked with multichannel physiological monitoring, biomechanical measurement, and human performance assessment systems.
- NUH-60FS Black Hawk Flight Simulator is an environmentally-controlled, full-motion, full-visual aeromedical research flight simulator. The system reproduces a wide range of environmental conditions of flight within the NUH-60 and records aircrew flight performance.
- Vision Research Facility is used for basic and applied research on the visual/optical physiology of the eye. The facility includes a laser ophthalmoscope, an optical distortion measurement system, hypoxia laboratory featuring a Reduced Oxygen Breathing Device, a micro-simulator with eye tracking technology, an optical fabrication laboratory and an Olympic-quality, multi-lane, precision air rifle range.



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QUESTIONS & ANSWERS

How does the civilian sector benefit from research conducted by the USAARL?

The results of the USAARL's research impact the civilian sector in several areas.

- Results from research using the Facial and Ocular Countermeasure for Safety Headform can be used to develop biomedically validated standards for facial, eye, head and neck protection and to design safer consumer products and sports protective equipment, like eyewear.
- Testing and evaluation of the blunt impact protection of helmets is conducted by the USAARL. Results contribute to the development of safer helmet designs and standards for the sporting and civilian air medical transport industries.
- Small business research efforts created and managed by the USAARL have resulted in improved data collection systems for use by the automotive and aviation industries to assess vehicle occupant crash safety.
- Testing and evaluation of medical systems intended for use on-board medical evacuation aircraft is conducted by the USAARL. Medical systems that meet military and industry standards are eligible for an airworthiness release, meaning the systems can be safely operated on-board U.S. Army fixed- and rotary-wing aircraft. These medical systems are developed by civilian companies and used in civilian aircraft.
- The Noise Immune Stethoscope provides medical care providers with the ability to detect heart sounds in noisy environments, where traditional stethoscopes are not effective.

- USAARL researchers are developing a tool that quantifies balance performance and provides sway feedback to improve balance. This device will be an effective tool for the rehabilitation of individuals with balance deficits due to injury (e.g., stroke, brain injury)

What USAARL products have transitioned to the civilian sector?

Products include:

- Return-to-Duty Toolkit: A toolkit to help clinicians determine Soldier readiness to return to duty following neurosensory injury, by helping clinicians interpret commonly performed clinical evaluations and understand their significance. The toolkit is organized by systems, or domains, and provides a description of each test, the required equipment, time, resources, outcome measures and basics of test interpretation.
- Facial and Ocular Countermeasure for Safety Headform: A research headform that is used to test and evaluate the performance of face and eye protective equipment by predicting the degree of eye injury and facial fracture sustained in blunt impact and blast environments.
- Helmet-Mounted Displays (HMD) Books: Two comprehensive texts on HMDs — the first book summarizes engineering issues pertaining to HMDs whereas the second book discusses the effects of HMDs on users' sensation, perception and cognition of visual and auditory displays.
- Color and the Rotary-wing Cockpit White Paper and Biodynamic Data Resource Book: Two manuscripts expected for publication in 2019.