

Annual Progress Report Fiscal Year 2012

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United States Army Aeromedical Research Laboratory

April 2013

U.S. Army Medical Research and Materiel Command
Fort Detrick, Maryland 21702-5012

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14. ABSTRACT
The Annual Progress Report includes a description of the research conducted by the U.S. Army Aeromedical Research Laboratory (USAARL) during fiscal year 2012 (FY12) and an overview of FY12 activities. It also summarizes the FY12 personnel and funding strength of the USAARL.

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Background

The United States Army Aeromedical Research Laboratory (USAARL) was originally established as the United States Army Aeromedical Research Unit (USAARU) in October 1962. As envisioned by Major General Spurgeon Neel, the unit's mission was to provide direct aviation medical research support to all Army aviation and airborne activities, and to provide a central aeromedical research and reference library. Technical evaluation of aircraft and personnel equipment, aeromedical in-flight observations, and field problems analysis reported by other aviation agencies were part of the unit's early research program.

In 1969, as USAARU's involvement in air mobility research grew, the Army re-designated the unit as USAARL. In 1970, the Helicopter In-flight Monitoring System, an airborne system capable of simultaneously measuring pilot and helicopter performance, was designed, built, and installed aboard the Laboratory's JUH-1J research helicopter. Lighting systems and paint schemes for collision avoidance were being addressed.

During the 1980s, USAARL scientists and support staff became increasingly involved in field studies throughout the Army in assessing hazards of military systems and operations, and biomedical means of enhancing Soldier selection, performance, and protection.

In 1990, USAARL was honored with the Department of Defense Award for Excellence. Two years later, in 1992, USAARL was awarded the Army Superior Unit Award for its support and contributions to Desert Shield/Desert Storm.

In April 2004, the USAARL building was dedicated in memory of Major General Neel for his integral role in the development of the principles of aeromedical evacuation of battlefield casualties.

Today, USAARL aims to provide medical research in the military operations environment to sustain the Warfighter's performance by delivering medical research to, and developing, testing, and evaluating solutions for air and ground Warriors. Specifically, the Laboratory's research includes developing return-to-duty standards for Soldiers suffering from neurosensory injuries, investigating mild traumatic brain injuries, determining the effectiveness of life support equipment, and preventing and mitigating ground crew and aircrew biomechanical injuries.

This report presents an overview of USAARL activities during fiscal year 2012 (FY12), identifies current areas of research, and gives a brief description of the research being conducted.

USAARL Mission and Vision

The USAARL's mission is to deliver medical research to, and develop, test, and evaluate solutions for air and ground Warriors.

Our vision is to be a premier team dedicated to excellence in innovative aeromedical and operational medical research.

From the Commander

USAARL is proud to present this summary of achievements for FY12. USAARL continued to make significant contributions to preserving and enhancing the health, safety, and combat effectiveness of the Warfighter. USAARL continued to establish collaborative partnerships with other military organizations, industry, and academia.



The Warfighter Health Division (WHD) investigated current and anticipated medical issues related to Warfighter psychological health and resilience. The division defined the biomedical impact of prototypical and developmental military equipment and translated the results into useable, relevant recommendations. The WHD successfully studied a helicopter display that uses the sense of touch, rather than the visual and auditory channels. This study showed the promise of tactile displays in helping Army pilots hover safely in degraded visual conditions.

During FY12, the Warfighter Protection Division (WPD) continued to provide relevant contributions to protecting medical personnel and patients during medical evacuation. They tested and evaluated the performance of 24 medical systems for use during en route care, ensuring the safe interaction among the vehicle, medical systems, patients, and care providers. WPD also continued to provide a helmet fit service for all Army aviators. The division continued their work on the Warrior Injury Assessment Manikin (WIAMan) effort, a blast injury research project aimed at creating a Warrior-representative test dummy and associated biomedically-validated injury assessment tools for use in live-fire test and evaluation and vehicle development efforts.

The Sensory Research Division (SRD) continued to lead a research effort in evaluating the impact of repetitive blast exposure on the auditory, vestibular, and visual systems of U.S. Marine Corps breachers. Using a USAARL-developed battery of tests called the Automated Binocular Vision Tester, researchers were able to detect subtle impairments of visual performance and physiology in mild traumatic brain injury (mTBI) patients. The SRD was instrumental in publishing a new helmet-mounted displays design standard that combines years of USAARL experience in the area of physiological optics with the latest information from combat theaters in Iraq and Afghanistan.

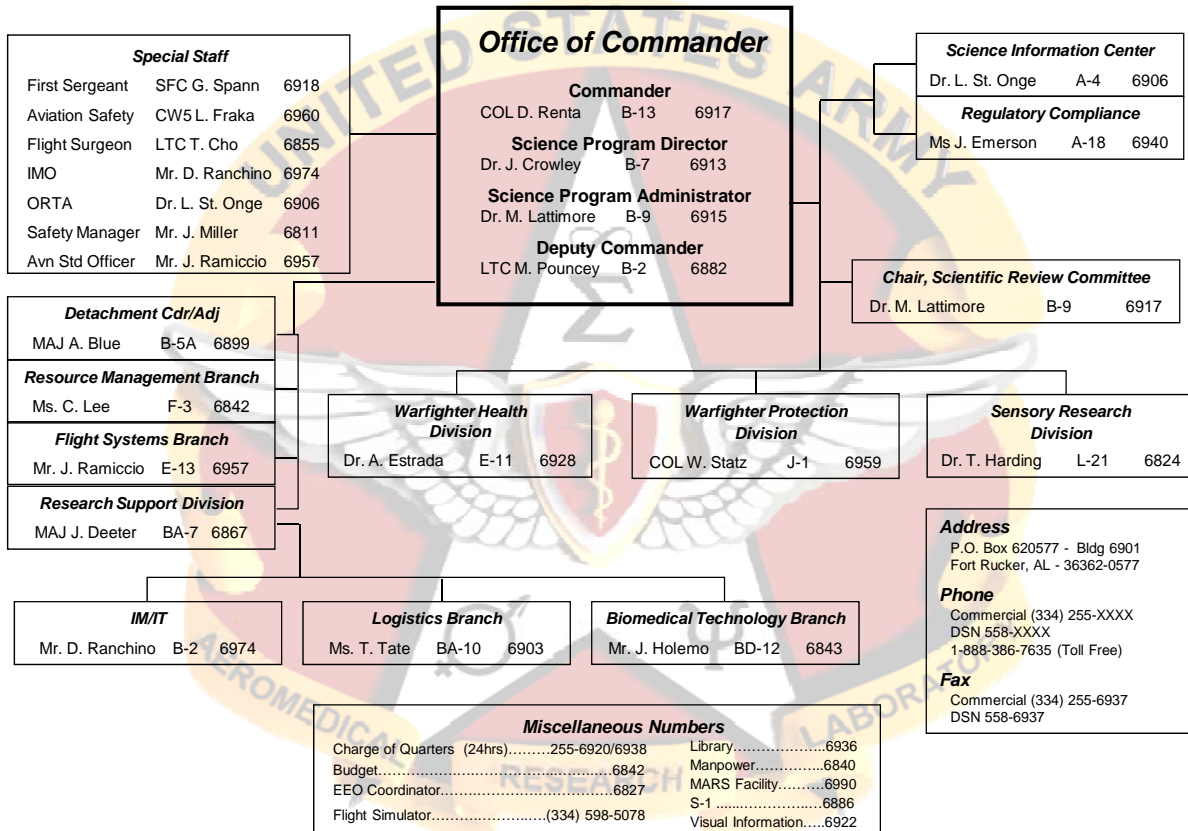
USAARL continued its success with the Gains in the Education of Mathematics and Science (GEMS) program, a science, technology, engineering, and mathematics (STEM) educational outreach program. In FY12, USAARL was pleased to announce a new program designed for 7th and 8th grade students, the Biochemistry GEMS, in which 35 students conducted experiments focused on chemistry, biology, and biochemistry. We also led a Neuroscience GEMS program for 50, 5th and 6th grade students who explored the five senses to learn more about the brain and neurological processes.

We are proud of the work we accomplished this year. During FY13, we will remain dedicated to our research efforts focused on protecting the Warfighter and supporting the U.S. Army Medical Department's (AMEDD) mission of, "serving to heal...honored to serve."

A handwritten signature in black ink, appearing to read "D. Renta".

DANA K. RENTA
Colonel, Medical Corps
Commanding

USAARL Organizational Chart



Human Resources

USAARL's FY12 required strength included 27 officers, 1 warrant officer, 33 enlisted, 72 civilians, and 6 contractors for a total of 139 requirements. Authorized personnel included 16 officers, 1 warrant officer, 27 enlisted, 46 civilians, and 6 contractors for a total authorized strength of 96. The average assigned strength was 13 officers, 1 warrant officer, 25 enlisted, 75 civilians, and 6 contractors for an average assigned strength of 120.

In addition to the work force described above, USAARL had a monthly average of 25 over-hires, 9 terms, and 40 non-Table of Distribution and Allowance (TDA) personnel during FY12. Non-TDA personnel include Student Temporary Employment Program personnel, on-site research and research support contractor personnel, exchange officers, and casual officers.

In FY12, USAARL employed a highly skilled and trained work force with 74 percent of assigned employees possessing higher education degrees. The types of degrees held by Laboratory employees as of 30 September 2012 were: 7 M.D., 18 Ph.D., 1 Au.D., 1 O.D., 14 Master, 34 Bachelor, and 8 Associate degrees.

Research and Development

Warfighter Health Division

The WHD is comprised of two branches: the Aeromedical Factors Branch (AFB) and the Cognitive Assessment and Diagnostics Branch (CADB). Together these branches maintain a unique capability in basic and applied research relating to the modern Warfighter. During FY12, the research objectives of WHD were to investigate current and anticipated medical issues related to Warfighter psychological health and resilience, including traumatic brain injury (TBI), post concussion syndrome, return-to-duty (RTD)/fitness-for-duty (FFD) issues, and physiological health. General scientific disciplines included aviation medicine, biomedical engineering, human factors, systemic and neurosensory physiology, and research psychology. In addition, WHD maintained its capability and competency to develop and document effective means of optimizing the performance of military personnel subjected to stressors such as spatial disorientation; disrupted sleep, work, and rest cycles; high cognitive workloads; and sustained operations. Within this heterogeneous framework, the WHD defined the biomedical impact of prototypical and developmental military equipment in terms of individual tolerance and performance effectiveness; assessed emerging technologies in all of the above research fields; and translated these research results into useable, relevant recommendations to the field. The WHD developed, maintained, and actively integrated technology transfers between other Department of Defense (DoD) laboratories and agencies, academia, the civilian scientific sector, and allied countries.

In FY12, the WHD staff was composed of both military and civilian employees. There were 11 investigators on staff with varying specialty areas including physiology, neurophysiology, neuropsychology, cognitive psychology, medicine, educational leadership, and human factors. The division staff was complemented by a research program coordinator, four research technicians, three contractors, one student, and six Soldiers skilled in medically-related fields. Division research included the use of a NUH-60FS Black Hawk helicopter flight simulator, tactile systems, cognitive assessment software tools, and an engagement skills weapons trainer.

Aeromedical Factors Branch

The AFB's mission is to support the Warfighter by conducting basic and applied research to quantify, attenuate, and mitigate operational stressors. During FY12, the research mission focused on the following areas: RTD assessments, crew/operator endurance and sustainment (aviation and ground vehicles), operator workload, collective team performance, situational awareness, motion sickness prevention, and advanced medical diagnostic tools. The AFB objectively and subjectively evaluated strategies to ameliorate the performance decrements and safety issues associated with fatigue and motion sickness through non-pharmacologic intervention. Ongoing research in emerging tactile technologies and visual displays pursued solutions for spatial disorientation and loss of situational awareness experienced during helicopter flight operations in areas of limited visibility/contrast (e.g., "brownout" landings). In addition, new medical devices designed for use in high noise environments and novel equipment designed to aid the assessment and rehabilitation of wounded Soldiers were developed, tested, and evaluated for their clinical efficacy and applications.

Cognitive Assessment and Diagnostics Branch

The mission of the CADB is to enhance Warfighter health and performance through state-of-the-art psychological and physiological research. Extended and frequent deployments in Iraq and Afghanistan have had serious repercussions for the Force, especially in aspects related to psychological health, cognitive performance, and family well-being. Research undertaken by CADB in support of the Warfighter includes examination of genetic and physiological underpinnings of TBI, the effects of sleep deprivation on cognitive performance, and the neuropsychological sequelae of combat exposure. By clarifying the contribution of key factors, CADB studies aim to improve diagnosis, assessment, and treatment for combat-related trauma outcomes, such as TBI and post-traumatic stress disorder (PTSD). Our work is achieved via multidisciplinary, biopsychosocial research that integrates traditional self-report methods with genetic, proteomic, and brain imaging data gathering techniques.

Research Accomplishments

The “Risky Behavior and Attitudes about Risk in Soldiers Pre- and Post-deployment” study assessed risk propensity in Soldiers pre- and post-deployment. A secondary goal was to assess risk propensity and actual risk behaviors in Soldiers post-deployment, comparing between those with PTSD, TBI, and poly-traumas. Results suggest that Soldiers engage in more alcohol use and reckless driving behaviors post-deployment. Details of the study are published in USAARL Technical Report 2012-08.

The study entitled “Studies Project: Touch/Tactile Feedback for Rehabilitation of Wounded Warriors” convened several select study groups of subject matter experts to assess the state of tactile balance feedback systems ultimately making recommendations concerning next generation devices and protocols. Details of the study are published in USAARL Technical Report 2012-10.

The “Team Performance Metrics and their Appropriateness for the U.S. Army: A Systematic Review” study conducted a systematic review of team performance metrics to identify those suitable for the Army’s team performance research needs. Out of the more than 50 measures, only 7 were considered most suitable. Details of the study are published in USAARL Technical Report 2012-11.

In FY12, the study entitled “Efficacy of Directional Tactile Cues from a Tactile Garment for Target Orientation in Helicopter Extractions over Moving Targets” assessed the efficacy of a tactile cueing system to provide nonverbal, tactile directional cues to the pilot as to the target’s ever-changing position. Data were collected and analyzed. A technical report is currently in progress.

A research project entitled “Clinical Assessment of the Noise Immune Stethoscope” evaluated the noise immune stethoscope (NIS), a dual mode electronic and Doppler device, at Madigan Army Medical Center. Insight from the evaluations, data collection, and analysis highlighted increased user confidence in using the acoustic over the Doppler mode on patients. A technical report detailing the results of the clinical assessment is currently in progress.

In FY12, the NIS received from the Aviation Engineering Directorate of the U.S. Army Research, Development, and Engineering Center (AMRDEC) an airworthiness release (AWR) for use of the device aboard H-60 medical evacuation (MEDEVAC) aircraft, 501(k) clearance from the U.S. Food and Drug Administration, and acquisition benchmark Milestone-C status from the U.S. Army Medical Research and Materiel Command (USAMRMC).

A current study, “The Perception of Looming Tactile Stimuli,” could determine whether tactile stimuli can convey the approach of significant objects. Data collection was completed in FY12. A technical report is currently in progress.

The goal of the study entitled “Traumatic Brain Injury Effects on Return-to-Duty for Specific Military Occupational Specialties” is to identify military occupational specialties likely to sustain TBI relative to the abilities required by those specialties for RTD. Information on injury patterns and affected jobs was gathered and assimilated. A technical report summarizing this data is currently in progress.

The objective of the study entitled “Identifying Functional Concussion Thresholds for Cognitive Impairment” is to systematically review the literature regarding performance decrements associated with various impact magnitudes and concussion grades. A secondary objective is to compile a list of currently available measurement technologies. A technical report is currently in progress.

A current project entitled “Evaluation of Current RTD Assessment Batteries: Examining the Statistical Validity of the Military Functional Assessment Program” evaluates the relationships between the clinical assessments of injured Soldiers and the Warrior Resiliency and Recovery Center’s (WRRC) military functional assessment program following treatment. A further goal is to assess the perceptions of leadership regarding the degree of RTD success exhibited by those treated at the WRRC. Data were collected and are under analysis.

The goal of the study entitled “Development of a Fitness-for-Duty Assessment Battery for Recovering Dismounted Warriors” examines the effects of mTBI on dynamic marksmanship abilities and weapons utilization tasks. The study will also demonstrate whether a new marksmanship assessment battery can supplement RTD assessments and determinations. The results of the study’s first phase show the narrow kneel and shoot task is the most reliable. Preliminary results were presented at the 2012 Military Health System Research Symposium. The study’s second phase of data collection is underway.

Warfighter Protection Division

The WPD is comprised of three branches, namely the Operational Survival Analysis Branch (OSAB), the Injury Biomechanics Branch (IBB), and the Airworthiness Certification and Evaluation (ACE) Branch. WPD’s overall vision is to focus on injury prevention including primary protection in the identification of health hazards, secondary protection in the development of standards for better protective equipment, and tertiary protection in the advancement of mitigating factors in the post-injury phase. The WPD mission is to conduct research on and develop standards for Warfighter injury mechanisms, human tolerance levels, injury risk mitigation technologies, and health hazards present in the full spectrum of Army

operational and training environments including aviation and ground operations, MEDEVAC platforms, combat vehicles, and weapons systems.

Operational Survival Analysis Branch

The OSAB is comprised on the Operational Survival Analysis Section (OSAS) and the Aviation Life Support Equipment Retrieval Program (ALSERP), which analyzes protective equipment to identify injury mitigation strategies.

The OSAS focuses on Warfighter personal protective equipment research, safety, and the identification of injury mitigation strategies. OSAS functions within the framework of the Joint Trauma and Prevention of Injury in Combat (JTAPIC) program, which encompasses multiple organizations as partners administered by USAMRMC. The USAARL contribution to the JTAPIC program centers on data procurement, analysis, and synthesis.

The OSAS team develops short notice responses to questions concerning injury mitigation, to include eye, ear, and hearing protection, from the U.S. Army and other government and non-government customers. Additionally, the team assists in informing research groups about the distribution and types of wounds occurring during current conflicts.

Under OSAB, the ALSERP serves a vital role in maximizing the level of protection afforded to Army aircrew members by analyzing aviation life support equipment (ALSE), studying injury mechanisms, tracking patterns, and bringing awareness to issues that can potentially decrease the level of protection afforded to Army aircrew members.

The objective of the ALSE section of ALSERP is to collect and analyze safety and protective equipment used or considered for use in U.S. Army aviation (and/or other DoD and non-DoD entities). Furthermore, this program is involved in the evaluation of aircraft interiors and other human factors issues within crew spaces. Results frequently identify unforeseen or previously unrecognized gaps in deployed equipment subsystems, in levels of human tolerance, and/or in current protection research. As such, the gaps are evaluated and transitioned into the core research program at USAARL through close associations with other research and development entities, and through various program managers and combat developers. Analyses of equipment and the discovery of deficiencies often prompt core research projects.

Injury Biomechanics Branch

The IBB's research centers on the impact of a full-spectrum of Army operational and training environments of Warfighters. The IBB is staffed by a multi-disciplinary team of biomedical and general engineers, a computer programmer, research facilitators, research technicians, and Soldiers. The team studies the effects of exposure to physical forces (e.g., localized and whole body impacts, and repeated jolt) on the health, safety, and performance of U.S. Army aviation and ground Warfighters. The IBB team uses various standardized and unique methods (e.g., epidemiological research, computer modeling, laboratory simulation, crash manikins and human volunteers, mishap investigations of combat ALSE studies, the investigation of ground vehicular incidents) and tools such as a helmet vertical drop tower, an 18-inch shock tube, a Multi-Axis Ride Simulator, and USAARL's NUH-60FS Black Hawk flight simulator.

Airworthiness Certification and Evaluation Branch

The ACE Branch maintains the capability of testing and evaluating the efficacy of medical systems in the U.S. military aeromedical evacuation environment, ensuring the safe interaction among medical equipment, patients, aircrew, and aircraft. As such, the ACE Branch contributes to the protection of the injured or ill Warfighter through the MEDEVAC system.

Research Accomplishments

In FY12, OSAS conducted detailed analyses of vehicle incidents (to include combat events and accidents) and personnel injuries.

The OSAS continued providing accident data procurement and analyses support to the mine-resistant ambush protected Joint Program Office and the AMRDEC Tank Automotive Research, Development, and Engineering Center (TARDEC) community.

The “Ocular Battle Injuries among U.S. Military Personnel, 2002-2011” study results revealed that explosive blast injury was the leading cause of military eye injuries for the past decade (2002 through 2011), and reinforced the need for military personnel to wear protective eyewear at all times during training and combat. The data were presented at the Fifth Military Vision Symposium on Ocular and Vision Injury.

ALSERP supported five, U.S. Army Combat Readiness/Safety Center (USACR/SC) Class A and two, Class B mishap investigations by providing analysis reports on safety and protective equipment.

The ALSERP/ALSE section personnel continued to provide a helmet fit service for all Army aviators.

The ALSE research protocol “A Study to Examine the Prevalence of Neck and Back Pain amongst Personnel at the Extremes of Anthropometric Measurements” found that aircrew with more flying hours were most likely to report severe back pain. Fifty-eight percent of aviators reported neck pain when flying. However, individuals with smaller sitting height, fewer flying hours, and a heavier night-vision goggle counterbalance weight reported less neck pain. Details of the study are published in USAARL Technical Report 2012-12.

The study “Performance Review of the Cockpit Air Bag System in the UH-60L and OH-58D(R), 2000 to 2009” found that, in mishaps where the vertical acceleration was below 25 G and the airbags deployed, occupants in the front seats sustained relatively minor injuries to the head, neck, and chest. It is likely that Cockpit Air Bag Systems, in combination with other aircraft protective systems, had a protective effect. Details of the study are published in USAARL Technical Report 2012-13.

In support of the U.S. Army, the ACE Branch performed airworthiness testing and/or certification on 24 medical items in FY12. Seventeen items of carry-on medical equipment were airworthiness tested for use aboard all H-series MEDEVAC helicopters; four items were airworthiness tested for use aboard the UH-72 Lakota aircraft; eleven items were certified and

added to the fleet-wide AWR; and 16 items were certified for use aboard the UH-72 Lakota. Three items were airworthiness tested for the U.S. Army Special Operation Forces, while two of these items were added to the fleet-wide AWRs for the MH-60 and MH-47 Chinook helicopters, respectively. In addition, ACE developed an airworthiness process for carry-on medical items for use on the CH-47 aircraft.

The U.S. Air Force testing laboratory at Wright-Patterson Air Force Base (WPAFB) in Dayton, OH accepted ACE test data for multiple medical items tested by USAARL.

The ACE Branch collaborated with the U.S. Marine Corps performing laboratory test and evaluation of one medical equipment item. This collaborative effort directly supported critical procurement decisions that resulted in fielding advanced medical technology to the Warfighter in support of military operations.

ACE personnel developed and executed a test plan to assess the use of maggots for debridement therapy during transport. This assessment included maggots' performance in cold temperature, hot temperature, altitude, and rotary-wing flight testing. Data collection was completed in FY12. A technical report is currently in progress.

The ACE Branch developed and executed a test plan for the Secure Telemedicine Evaluation (Roamer/Tempus Exercise). This exercise demonstrated the transmission of simulated patient physiological data through a secured network while in flight to a fixed facility. The USAARL JUH-60A helicopter was used for this exercise, which marked the first successful helicopter telemedicine exercise for the DoD.

The ACE Branch and WPAFB finalized the Joint En Route Care Equipment Testing and Certification Standard. This standard was approved by USAARL, the Aviation and Missile Research Development and Engineering Center, and the U.S. Air Force.

The ACE Branch collaborated with the University of Nevada Las Vegas (UNLV) to identify and develop shock and vibration isolation systems for patients during ground and air MEDEVACs. The ACE-UNLV team modified existing air bladder technology to fit under supine litter patients and seated patients. Next, the team evaluated the prototypes of the modified air bladder technology. Mechanical shock and vibration data were collected with and without the air bladder technology during simulated patient transport in an RG-33L mine-resistant ambush protected ambulance over various terrain types. Overall, results indicate the air bladders provided shock and vibration attenuation in key frequency ranges, with the greatest benefit noted in the seat bladders for the ground evacuation platform.

IBB, TARDEC, and the U.S. Army Research Laboratory continued their work on the WIAMan effort, a blast injury research project aimed at creating a Warrior-representative test dummy and associated biomedically-validated injury assessment tools for use in live-fire test and evaluation and vehicle development efforts.

Sensory Research Division

The SRD maintains a unique capability in applied medical and operational research in the areas of visual and auditory sciences through the Visual Sciences Branch and Acoustics Research Branch. SRD's mission is to conduct sensory research to protect, sustain, and extend the operational capabilities of our Army's Warfighters. These objectives include conducting applied medical research in the areas of (a) eye and ear injury prevention; (b) development of sensory biomarkers (e.g., electrophysiological, behavioral, and clinical) for the evaluation of visual, auditory, and vestibular consequences of traumatic brain injury and fitness for duty criteria development; (c) development of realistic models for the assessment of protection technologies and sensing performance with these technologies; (d) development of unique visual and auditory standards for service occupations and performance standards for optical, acoustical and communication devices; and (e) establishment of a sensory performance research base to support the development and integration of Soldier technologies (e.g., night vision devices, hearing protection, communications equipment, advanced optical systems, etc.) into military systems.

Visual Sciences Branch

The SRD maintains a unique capability in the visual sciences as they relate to military operational medicine. The division builds on its expertise in the clinical and allied vision sciences to enhance Warfighter effectiveness and safety in the evolving battlefield environment of today. The SRD's vision science, optical, clinical, and technological capabilities provide a basis for the development and integration of optical and electro-optical displays in military systems; the evaluation of physical, physiological, and functional vision associated with military occupational demands and combat, the definition of countermeasures to improve and preserve vision and visual efficiency, particularly as applied to unaided visual target detection, recognition, and identification. Of particular concern are the evolving threats to the visual system posed by battlefield blast injuries.

Acoustics Research Branch

The SRD maintains a specialized capability in the acoustics research. The objectives of the Acoustics Research Branch are to conduct research to improve the operational capabilities of Army aviation, mounted, and ground forces by predicting and reducing hazards from excessive exposure to noise, and to improve the safety and mission capabilities of Army personnel by improving the auditory displays and communications systems utilized in military aircraft and ground vehicles. Warfighters' survivability depends on accurate sensory perception of the environment. Despite the technological advances in hearing protective devices, the likelihood of exposure to continuous and impulse noise on the modern battlefield remains high. As a result, the prevalence of hearing loss and tinnitus in Soldiers returning from theatre is at an all-time high; making protection of the critical sense of hearing a priority of the Acoustics Research Branch. Warfighter auditory performance research efforts focus on prevention of noise-induced hearing loss and enhancement of auditory performance. Furthermore, research efforts are focused on evidence-based criteria for standards to determine the level of operational competence required to RTD following an auditory or vestibular injury.

Research Accomplishments

“Visual Dysfunctions and Symptoms during the Subacute Stage of Blast-Induced Mild Traumatic Brain Injury” assessed the occurrence of visual dysfunction and associated symptoms in active duty Warfighters during the sub-acute state of blast-induced mTBI. The results indicated the most common mTBI-induced visual dysfunctions were associated with near eye movements. These dysfunctions were significantly associated with reduced reading speed and comprehension. In addition, photosensitivity was a common visual dysfunction found within the mTBI population. This was published in *Military Medicine*.

The “Effectiveness of Computerized Oculomotor Vision Screening in a Military Population: Pilot Study” evaluated the effectiveness of a computerized oculomotor vision screening (COVS) tester in a military population. If proven to be valid, the COVS could be used as a screening device for non-eye care professionals in evaluating eye movement functions. The results showed that the COVS tester had high sensitivity and specificity for screening near oculomotor functions. This study demonstrated that non-eye-care professionals may be able to use the COVS as a tool to efficiently screen oculomotor functions in a military population with or without mTBI. This was published in the *Journal of Rehabilitation Research and Development*.

“Evaluation of Wavefront-Guided Ophthalmic Lenses for Correction of Higher-Order Visual Aberrations” assessed an emerging ophthalmic lens technology that purports to improve best corrected visual acuity through the use of higher-order optical aberration guided spectacle optical correction. Corneal refractive surgery currently utilizes higher-order aberration information in formulating the optical correction used. Results thus far indicate that the new technology does not provide significant improvement over traditional lens correction. Data collection and initial analysis were completed and a final report is in preparation.

“The Effects of Hypoxia on Photoreceptor Function, Oculometrics, and Visually-Guided Aviation Performance” study assessed the effects on the visual system of short-term exposures to hypoxia of the kind that can be typically encountered by aircrew personnel in theatre. The visual measurements addressed color vision and oculometrics. Data collection was completed and preliminary analysis of color vision shows deficits in Red-Green color vision during exposure to hypoxia.

The “Traumatic Brain Injury and Hypoxia” study assessed whether short-term exposures to hypoxia of the kind that can be typically encountered by aircrew personnel in theatre will uncover symptoms of mTBI in individuals with a history of such trauma, but who are asymptomatic under normal sea level conditions. Data are currently being analyzed. Preliminary analysis supports the hypothesis that the hypoxic stress caused a statistically significant deficit in memory function by comparison to the control subjects.

The “Evaluation of Field of View in Degraded Visual Environments” study assessed an emerging technology, developed by Army Night Vision Laboratory’s Air Systems Division, to test its ability to mitigate the effects of blowing sand, commonly referred to as ‘Brownout,’ on helicopter landing operations. USAARL evaluated the effect of field-of-view on a specified heads down display (Boland) for landing operations in degraded visual environments. Data collection and analysis indicate that (1) the eight test pilots’ subjective reports were in agreement

with objective measures of flight performance; (2) USAARL's 'Brownout' simulation was effective in degrading flight performance; (3) the technology demonstrated the effect of field-of-view on operational performance; and (4) possible paths to improving the implementation of the landing aide exist. A technical report is currently in progress.

"Auditory and Vestibular Effects of Repeated Impulsive Noise" evaluated the noise hazards from weapon systems used on U.S. Army Special Operations aircraft, particularly the MH-60 Direct Action Penetrator. Prior year efforts provided measurements of the noise levels produced by the weapon systems on board this aircraft. During FY12, the continuous and impulsive noise insertion loss was measured for standard Army hearing protection devices for aviators (HGU-56/P helmet with the communication earplug). Results indicated that most individuals operating the aircraft suffered from nausea and headaches associated with motion and air quality on board the aircraft. Details of the study are published in USAARL Technical Report 2012-14.

Research Activities

Publications

- Albery, W. (Ed.). (Estrada, A., contributing author). (2012). *Rotary-Wing Brownout Mitigation: Technologies and Training*. North Atlantic Treaty Organisation, Research and Technology Organisation, RTO Technical Report TR-HFM-162.
- Athy, J. R. (2011). Aerial Command and Control of Unmanned Aircraft Systems. In H. Williams, B. Hartzler, S. Eggan, W. Wells, F. Varino, & R. Arnold (Eds.), *Proceedings of the Unmanned Aircraft System/Remotely Piloted Aircraft (UAS/RPA) Human Factors and Human Systems Integration Research Workshop* (pp. 21-22). Dayton, OH.
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Presentations

MAJ David Walsh presented “Adaptation to Simulated Central Scotomas” by Walsh, D. V., & Liu, L. at the annual American Academy of Optometry meeting in Boston, MA, 12-15 October 2011.

A poster entitled “Evaluation of Sound Therapy Tinnitus Treatment” by Hill, M. E., Casto, K. L., & Nedostup, A. E. was presented at the State of the Science Meeting: Blast-Related Tinnitus in Chantilly, VA, 15-16 November 2011.

CPT Michael Dretsch presented “No Evidence of Effect of Deployment Environment or Non-concussion Injury on Neurocognitive Functioning in Soldiers Deployed to Iraq” at the 4th Annual Trauma Spectrum Conference in Bethesda, MD, 8-9 December 2011.

CPT Michael Dretsch presented “Neurocognitive Performance of Concussed Soldiers without Loss of Conscious, Post-traumatic Amnesia, or Symptoms” at the 4th Annual Trauma Spectrum Conference in Bethesda, MD, 8-9 December 2011.

CPT Michael Dretsch and Kenneth Thiel presented “A Longitudinal Study Assessing the Link between Mild Traumatic Brain Injury, Neuropsychological Functioning, Proteomics, and Genetics in the U.S. Warfighter” at the Society for Neuroscience conference in Washington, D.C., 12-16 November 2011.

Dr. Art Estrada presented “Tactile Situation Awareness System” at the 2012 Spatial Disorientation Countermeasures Conference at WPAFB in Dayton, OH, January 2012.

Dr. Art Estrada presented “SD Training in the U.S. Army in 2012” at the 2012 Spatial Disorientation Countermeasures Conference at WPAFB in Dayton, OH, January 2012.

Dr. William Ahroon presented “Hearing Protective Device Field Attenuation Estimation Systems-Round Robin Evaluations” at the 37th Annual Hearing Conservation Conference in New Orleans, LA, February 2012.

Dr. Art Estrada presented “Sensorimotor Interaction with Vehicle Displays and Controls to Enhance Human-Machine Cooperation during Precision Lunar Landing” at the NASA Human Research Program Investigators’ Workshop in Houston, TX, 14-16 February 2012.

Dr. Angus Rupert presented “Modification of Motion Perception and Manual Control Following Short-Duration Spaceflight” at the NASA Human Research Program Investigators’ Workshop in Houston, TX, 14-16 February 2012.

LTC Kristen Casto presented “In-Flight Speech Intelligibility Evaluation in Service Members with Peripheral Hearing Loss: Case Report” by Casto, K. L., & Cho, T. H. at the Joint Defense Veteran’s Audiology Conference in Dallas, TX, 19-21 March 2012.

LTC Kristen Casto presented “Evaluation of a New Treatment for Tinnitus” by Hill, M. E., Casto, K. L., & Nedostup, A. E. at the Joint Defense Veteran’s Audiology Conference in Dallas, TX, 19-21 March 2012.

MAJ Scott McIlwain presented “Otolaryngology Technologist Education and Training” at the Joint Defense Veteran’s Audiology Conference in Dallas, TX, 19-21 March 2012.

CPT Michael Dretsch presented “Assessing the Relationship between Neurocognitive Functioning and Mild Traumatic Brain Injury in the U.S. Warfighter” at the Scotland Brain Injury Conference in Scotland, 19-23 March 2012.

Melody King presented a poster entitled “The Relationship between Motion Sickness Symptoms and Marksmanship” by King, M., Webb, C. M., Erickson, B., Estrada, A., Athy, J. R., & Kelley, A. M. at the Aerospace Medical Association’s (AsMA) 83rd Annual Scientific Meeting in Atlanta, GA, May 2012.

Catherine Webb presented “Motion Sickness Prevention by 8 hz Stroboscopic Environment during Air Transport” by Webb, C. M., Estrada, A., & Athy, J. R. at AsMA’s 83rd Annual Scientific Meeting in Atlanta, GA, May 2012.

Dr. Leonard Temme presented “The Bland-Altman Statistical Approach for Assessing Agreement among Measures: Are We Measuring the Same Thing?” by Still, D. L., Temme, L. A., & Capó-Aponte, J. at AsMA’s 83rd Annual Scientific Meeting in Atlanta, GA, May 2012.

Dr. Leonard Temme presented, “Estimating Battlefield Ocular Trauma in 2020 and beyond” by Still, D. L., Temme, L. A., & Capó-Aponte, J. at the AsMA’s 83rd Annual Scientific Meeting in Atlanta, GA, May 2012.

Dr. Morris Lattimore presented “Inferred Effect of Spherical Aberration on Visual Acuity as Measured by the Rabin Small Letter Contrast Test (SLCT)” at AsMA’s 83rd Annual Scientific Meeting in Atlanta, GA, May 2012.

Lei Liu and MAJ David Walsh presented “The Effects of the Profile of a Simulated Central Scotoma on Visual Search Performance” by Liu, L., & Walsh, D. V. at the Association for Research for Vision and Ophthalmology meeting in Ft. Lauderdale, FL, 6-10 May 2012.

An abstract entitled “Lunar Dust Challenges to Astronaut Landing” by Young, L. R., Clark, T. K., Estrada, A., & Tritchler, S. E. was presented at the Dust, Atmosphere and Plasma: Moon and Small Bodies Conference in Boulder, CO, June 2012.

Dr. Ben Lawson and Dr. Angus Rupert presented an abstract entitled “Evaluation and Rehabilitation of Vestibular Balance Deficits in the Military Setting: Recommendations from Expert Working Groups” at the 27th Barany Society Meeting in Uppsala, Sweden, 10-13 June 2012.

Dr. Ben Lawson presented “The Prevention of Aircraft Upset and Improved Recovery from Aircraft Upset using Continuous Tactile Cueing” by Newman, M., Lawson, B., McGrath, B., & Rupert, A. at the American Institute for Aeronautics and Astronautics Modeling and Simulation Technologies Conference in Minneapolis, MN, 13-16 August 2012.

A poster entitled “Acute Effects of Head-Supported Mass and Head Position on Nerve Function” by Shivers, B., Dorman, D., Bumgardner, B., Gray, M., Brezzo, R., & Chancey, C. was presented at the Military Health System Research Symposium (MHSRS) in Fort Lauderdale, FL, 13-16 August 2012.

Dr. Leonard Temme presented “Projecting Battlefield Ocular Trauma Incidence to 2020 and beyond” by Temme, L., Still, D., & Capó-Aponte, J. at the MHSRS in Fort Lauderdale, FL, 13-16 August 2012.

Catherine Webb presented “Development of a RTD Battery for Recovering Dismounted Warfighters: Phase 1” by Webb, C., Lawson, B., King, M., Cruz, P., Kelley, A., & Erickson, B. at the MHSRS in Fort Lauderdale, FL, 13-16 August 2012.

Tyler Rooks presented a poster entitled “Variability of Strain and Strain Rate in the Human Tibial Diaphysis” at the American Society of Biomechanics meeting in Gainesville, FL, 15-18 August 2012.

Michael Lo and LTC Jose Capó-Aponte presented a poster entitled “Ocular Battle Injuries Among U.S. Military Personnel, 2002-2011” by Lo, M., Capó-Aponte, J., Wise, D., Simpson, D., Barrett, A., Giffin, B., Pakulski, K., & Temme, L. at the Fifth Military Vision Symposium on Ocular and Vision Injury hosted by the Schepens Eye Research Institute of Harvard Medical School in Boston, MA, 18-20 September 2012.

MAJ Scott McIlwain presented “Aviation Functional Hearing Assessment” at the Return-to-Duty Conference in Frederick, MD, 19-20 September 2012.

Tours/Distinguished Visitors

Tours of USAARL are provided to distinguished visitors, military students studying at Fort Rucker, and local schools. Tours typically include demonstrations of USAARL’s research capabilities, technologies, and current and historical research efforts in support of the U.S. Army Aviator and Soldier.

Date: 12 October 2011

Visitors: MG David Rubenstein and COL Randall Anderson (AMEDD Center and School)

Purpose: To examine USAARL’s capabilities in preserving and enhancing the health, safety, and combat effectiveness of the U.S. Army Warfighter

Dates: 25-26 October 2011

Visitor: Angela Mackey (WRRC)

Purpose: To meet with USAARL personnel regarding upcoming protocols and funding

Date: 28 October 2011

Visitor: BG Kevin Mangum (U.S. Army Special Operations Command)

Purpose: To discuss the technology behind the tactile situational awareness system (TSAS), and receive a TSAS demonstration in USAARL's flight simulator and research helicopter

Date: 8 November 2011

Visitor: COL Stephen Seitz (Directorate of Simulation)

Purpose: To examine USAARL's capabilities in preserving and enhancing the health, safety, and combat effectiveness of the U.S. Army Warfighter

Date: 16 November 2011

Visitors: Visitors from Navy Hospital Pensacola and Naval Aerospace Medicine Institute

Purpose: To discuss potential research collaborations on balance research

Date: 15 December 2011

Visitors: Visitors from Marshall University

Purpose: To receive a TSAS demonstration in the flight simulator and discuss potential research collaboration discussion

Dates: 30 January-3 February 2012

Visitors: NATO RTO RTG-184 working group

Purpose: To discuss the development of standards for unmanned aerial system casualty evacuation

Dates: 23-24 February 2012

Visitors: MG James Gilman (Commanding General, USAMRMC) & SES Richard Sayre (Director, DoD Live Fire Test and Evaluation)

Purpose: To review status and progress of the WIAMan project

Dates: 28-29 February 2012

Visitors: Rachele Mainard (Geneva Foundation, Grants and Contracts Director) and Jim Hulbert (Geneva Foundation, Research and Development Manager)

Purpose: To meet with Geneva Foundation employees and USAARL principal investigators, and tour the laboratory

Date: 5 March 2012

Visitors: Students from Fort Rucker's Flight Surgeon course

Purpose: To examine USAARL's capabilities in preserving and enhancing the health, safety, and combat effectiveness of the U.S. Army Warfighter

Date: 6 March 2012

Visitors: Students from Troy University

Purpose: To examine USAARL's capabilities in preserving and enhancing the health, safety, and combat effectiveness of the U.S. Army Warfighter

Dates: 12-14 March 2012

Visitors: Pentagon Channel representatives

Purpose: To film a television segment about TSAS technology

Date: 13 March 2012

Visitors: Students from the Dauphin Junior High School science club

Purpose: To examine USAARL's capabilities in preserving and enhancing the health, safety, and combat effectiveness of the U.S. Army Warfighter

Date: 14 March 2012

Visitors: Students from Fort Rucker's Spanish Aviation Safety Officer course

Purpose: To examine USAARL's capabilities in preserving and enhancing the health, safety, and combat effectiveness of the U.S. Army Warfighter

Date: 22 March 2012

Visitors: Students from the Dale County Christian School

Purpose: To examine USAARL's capabilities in preserving and enhancing the health, safety, and combat effectiveness of the U.S. Army Warfighter

Date: 23 March 2012

Visitors: Students from A.T. Still University, School of Osteopathic Medicine

Purpose: To examine USAARL's capabilities in preserving and enhancing the health, safety, and combat effectiveness of the U.S. Army Warfighter

Date: 11 April 2012

Visitors: LTC Dave Hickey (USACR/SC) and Ken Neubaur (Navy Safety Center)

Purpose: To discuss stimulant research

Date: 30 April 2012

Visitors: Students from Fort Rucker's ALSE course

Purpose: To examine USAARL's capabilities in preserving and enhancing the health, safety, and combat effectiveness of the U.S. Army Warfighter

Date: 30 May 2012

Visitors: SES Kenneth Bertram (USAMRMC Principal Assistant for Acquisition), John Meirose (U.S. Army Medical Materiel Agency, Deputy for Acquisition), and Charlie Paschal (MEDEVAC Project Manager)

Purpose: To receive a tour of USAARL and review status and plans for the MEDEVAC inferior upgrade program

Date: 8 June 2012

Visitors: MG Philip Volpe (Commanding General of Western Regional Medical Command and Senior Market Executive for TRICARE Puget Sound)

Purpose: To receive an overview briefing and tour regarding USAARL mission and airworthiness effort

Date: 20 June 2012

Visitors: Students from Fort Rucker's Spanish Aviation Safety Officer course

Purpose: To examine USAARL's capabilities in preserving and enhancing the health, safety, and combat effectiveness of the U.S. Army Warfighter

Date: 22, 29 June & 13, 20 July 2012

Visitors: GEMS program participants and staff

Purpose: To learn more about the research conducted at USAARL and to explore DoD professions in the fields of science, engineering, and psychology

Dates: 25-26 September 2012

Visitors: Betty Crosby (Henry M. Jackson Foundation Program Management Office) and Lidia Soliszewska-Johnson (Henry M. Jackson Foundation Sponsored Programs Office)

Purpose: To meet with Henry M. Jackson Foundation employees and USAARL research support staff, and tour the Laboratory

Research Support

Flight Activities

Since 1959, USAARL's Flight Systems Branch (FSB) has served the aviation community by providing world-class aeromedical research aboard our one-of-a-kind JUH-60A aircraft and NUH-60FS flight simulator. USAARL's prestigious identity and the ability to conduct this critical aeromedical mission depend on the aviation capabilities and assets we possess.

During FY12, the FSB personnel included one research helicopter instructor pilot, one Army Reserve Individual Mobilized Augmentee Army Medical Department Officer, and two active-duty officers serving as a flight operations officer and instructor pilot. FSB personnel flew a total of 1397.5 hours in USAARL's aircraft and simulator. Specifically, 228 hours in the JUH-60A; 31.5 hours in the UH-60M; 11.8 hours in the HH-60M; 4 hours in the CH-47F; 2 hours in the UH-72A; and 1120.2 hours in the NUH-60FS. In addition, the U.S. Army Aviation Center of Excellence (USAACE) G-3 flew over 191 VIP and general support flight hours using USAARL's JUH-60A. In support of USAACE, FSB personnel provided assistance in ferrying multiple UH-60 aircraft to and from maintenance facilities.

FSB pilots continued USAARL's phenomenal accident and incident free safety and performance record. In FY12, USAARL pilots flew more than 500 hours, accident and incident free. To date, USAARL has had zero Class A, B, or C aviation accidents.

In FY12, the branch completed, in support of the USAARL ACE Branch, the inaugural Secure Telemedicine Evaluation (Roamer/Tempus Exercise) aboard USAARL's JUH-60A. FSB logged over 30 hours of aviation support during the event, which took place at Fort Dix, NJ. During pre-flight checks, our crew discovered a serious maintenance problem with the tail rotor. With assistance from the New Jersey National Guard maintenance crews, the tail rotor was replaced in record time, the exercise objectives were completed, and the aircraft flew back to Fort Rucker incident and accident free.

Also in FY12, FSB supported USAARL's ACE branch by assisting with the testing of medical devices for the U.S. Army aircraft fleet.

Using the HH-60M MEDEVAC helicopter, FSB performed ground breaking vibration mitigation testing using a vibration absorbing blanket system designed to shield litter-fastened patients from the environmental vibration caused by helicopters in flight.

During FY12, USAARL's JUH-60A helicopter was used in a novel patient litter load test for the MEDEVAC Program Office. This human factors functional test assessed the use of a moveable litter lift system versus a fixed position litter system aboard the H-60 MEDEVAC equipped helicopter fleet.

During FY 12, USAARL's NUH-60 flight simulator supported the "Spatial Orientation Estimation during Piloted Lunar Landing Terminal Descent Trajectories" and "Efficacy of Directional Tactile Cues from a Tactile Garment for Target Orientation in Helicopter Extractions over Moving Targets" protocols.

Nearly one-half of the flight simulator's total device utilization in FY12 was comprised of training to the following installations: USAACE; Department of Simulation; Director of Evaluation and Standardization; Army Training Modernization Directorate/G-3; E Company 1-212th Flight School XXI; the Foreign Officer Liaison offices; MEDEVAC Proponency; and students of the U.S. Army Flight Surgeons Course and Aviation Safety Officers Course.

The FSB, in support of the U.S. Army Medical Command (MEDCOM), provided aviation standardization consultation to the San Antonio Military Medical Center (SAMMC) in Fort Sam Houston, TX. The FSB officially certified the first roof-top hospital helipad at SAMMC and developed SAMMC aviation standard operating procedures and the Aviation Procedures Guide, which establish policies and procedures to safely utilize the roof-top helipad and for annual inspections of MEDCOM helipads. The branch also conducted helipad safety training for SAMMC emergency department personnel.

In FY12, FSB staffed and processed the 2011-2013 aircrew training program waiver for the U.S. Army Medical Department Center and School for aviators assigned to installations that lacked aviation resources, and provided training support and standardization consultation to the MEDEVAC Proponency Office.

Science Information Center

During FY12, the Science Information Center (SIC) contributed to the quantity and quality of research products to include technical reports, technical memoranda, open literature manuscripts, verbal presentations, and poster presentations; published media articles, a monthly newsletter, and public relations brochures and pamphlets created to describe and promote the research conducted by the USAARL scientists and engineers; strengthened the laboratory's public relations program aimed at marketing USAARL's unique talents and assets; managed numerous metrics contained in the laboratory's balance score card; responded to Freedom of Information Act requests; and created an archive of USAARL photos and documents dating back to 1962, when the organization was first established.

The SIC library provided the information necessary to support the research performed at USAARL and disseminated scientific information to requestors worldwide. It also supported the staffs of Lyster Army Health Clinic, the U.S. Army Aeromedical Activity, and the U.S. Army School of Aviation Medicine including the Flight Surgeon Courses held at Fort Rucker throughout the year. The library holdings are believed to comprise the most comprehensive aviation medicine collection in this part of the country. Additionally, the SIC library is a member of a national library consortium that, through interlibrary loans, exponentially expands each member's resources at minimal cost to each member.

The SIC administers and maintains an active technology transfer program through the distribution of USAARL's technical reports, publications in the open literature, presentations to military and civilian audiences, execution of Cooperative Research and Development Agreements (CRADAs) and Material Transfer Agreements (MTAs), and protection of intellectual property through invention disclosures and patenting. In FY12, 18 new CRADAs/MTAs were fully executed and 21 existing CRADAs/MTAs were maintained between USAARL and collaborators. The collaborators funded USAARL for a total of \$41,470. The laboratory also executed two, Education Partnership Agreements, which resulted in the donation of research and/or computer equipment to area schools.

The USAARL is actively engaged in the science, technology, engineering and math (STEM) education of students of all ages. The SIC oversees the Oak Ridge Institute for Science and Education (ORISE) Research Participation Program (RPP). High school and college students, post-graduates, and post-doctoral fellows appointed to the ORISE RPP gain practical experience conducting research under the mentorship of a USAARL scientist or engineer. In FY12, USAARL mentored 15 ORISE fellows. The SIC also coordinates and implements a summer, STEM education program, the GEMS program, for school-aged students. GEMS participants, who are mentored by college students, learn numerous math and science concepts; practice the scientific method, problem solving, and speaking in a public forum; gain exposure to a laboratory setting; and interact with military and civilian technicians, clinicians, scientists, and engineers. During summer FY12, USAARL offered Neuroscience GEMS and Biochemistry GEMS for 5th through 8th graders. 85 students and 6 mentors participated in the program.

Regulatory Compliance

The USAARL Regulatory Compliance Office (RCO) ensures the research and T&E conducted by USAARL investigators is compliant with federal laws, policies, and procedures, regulating such research activity.

In FY12, the RCO provided eight educational sessions and offered other research educational opportunities for all principal investigators, associate investigators, and key research personnel. This training summarized new regulatory requirements and changes to existing requirements that may affect the way we perform research. The RCO training sessions also reviewed research ethics, the Health Insurance Portability and Accountability Act, the scientific review process, the protocol/testing activity approval process, and standardization of research file maintenance. During FY12, the RCO provided ombudsman training for all of USAARL's enlisted personnel (E-5 and below) to meet the unique requirements for using and recruiting military personnel for voluntary participation in research. This training ensured that the USAARL ombudsmen

understand their role in research and are informed of the regulatory requirements of human subject research.

The RCO performed post-Institutional Review Board approval monitoring of 100 percent of the USAARL investigators' master files and 10 percent of their subject files. The RCO provided credentialing and privileging for all principal investigators' and associate investigators' privileges or specialized human use procedures. This office received top marks from the USAMRMC Office of Research Protections and the USAMRMC IRB post-IRB approval monitoring inspection, and was commended for our best practices.

Information Management

The information technology group established the WIAMan FTP Server, which serves as the sole medical-related WIAMan data repository, providing file upload and download capability to all WIAMan partners and participants.

During FY12, 90 percent of the laboratory's computers were updated to Windows® 7. All computers will be upgraded to Windows® 7 by January 2013.

Resources Management and Budget

Program funding for FY12/FY13 (dollars in thousands):

		FY12	FY13*
6.1	Basic Research	165	169
6.2	Applied Research	7,135	5,430
6.3	Advanced Technology Development	4,620	3,279
6.4	Demonstration and Validation	1,019	400
6.5	Engineering and Manufacture Development	909	681
	Other	8,955	2,173
	TOTAL	\$22,803	\$12,132

*Estimated funding for FY13



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