USAARL-TECH-BB--2024-02

UNITED STATES ARMY AEROMEDICAL RESEARCH LABORATORY

U.S. Army Aeromedical Research Laboratory
Fiscal Year 2023
Annotated Bibliography

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14. ABSTRACT

Open literature publications, technical reports, and technical memorandums by the United States Army Aeromedical Research Laboratory (USAARL) in Fiscal Year (FY) 2023 are included in this annotated bibliography, this edition dated October 2023.

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Foreward

Open literature publications, technical reports, and technical memorandums by the United States Army Aeromedical Research Laboratory (USAARL) in Fiscal Year (FY) 2023 are included in this annotated bibliography, this edition dated October 2023.

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Summary of Technical Products

For FY23, USAARL published 5 open literature manuscripts, 33 technical reports, and 11 technical memorandums, totaling 49 publications. USAARL delivered 39 oral presentations and 12 poster presentations.

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Open Literature Publications

Regional strain response of an anatomically accurate non-human primate finite element brain model under frontal impact.

Article published in *Traffic Injury Prevention,* 2022.
DOI: 10.1080/15389588.2022.2124813

By Rooks, T., Baisden, J., Chancey, V. C., & Yoganandan, N.

Introduction: Prevention and treatment of traumatic brain injuries is critical to preserving Soldier brain health. Laboratory studies are commonly used to reproduce injuries, understand their mechanisms, and develop tolerance limits; however, this approach is not appropriate for studying brain injury, which requires a physiological response. The non-human primate (NHP) has been used as an effective model for investigating brain injury and neuropsychology for many years; however, due to the sensitivity of testing NHPs, we must rely on archival and legacy datasets. The objectives of the present study are to develop an anatomically accurate finite element model of the NHP and determine regional brain responses using archival data.

Methods: The finite element model was developed using an anatomical atlas of the rhesus macaque. The regions of interest were identified as cortical and subcortical structures. The head kinematic data from ten sagittal NHP experiments, four Gx (rearward) and six -Gx (frontal), were used to test stability, evaluate mesh quality, and obtain brain strain responses from multiple severities and directions.

Results: For Gx tests, whole brain CSDM15 was 0.89, 0.83, 0.76, and 0.28 and whole brain MPS95 was 0.59, 0.35, 0.30, and 0.21. For -Gx tests, whole brain CSDM15 was 0.66, 0.52, 0.24, 0.24, 0.18, and 0.02, and whole brain MPS95 was 0.39, 0.25, 0.20, 0.13, 0.11, and 0.08.

Conclusions: Recognizing that the NHP is the closest surrogate to the human and the sensitivities in conducting brain injury experiments in a laboratory setting, a detailed anatomically accurate finite element model of an NHP was developed and exercised using archival data from Naval Biodynamic Laboratory. The model incorporated cortical and subcortical anatomical structures. The model was exercised using two loading vectors, Gx and -Gx, across a range of severities, and showed the ability to discriminate between injurious and non-injurious tests.

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Applying a military teleophthalmology mobile app in a noncombat emergent care setting.

Article published in *Military Medicine*, 2023.
DOI: 10.1093/milmed/usac345

By Chung, R., Legault, G., Stowe, J., Miller, K. Moccia, M., Cooper, M., Little, J., & Gensheimer, W.

Introduction: Teleophthalmology has a natural role in the military due to the inherent organization of its medical system, which provides care to patients in remote locations around the world. Improving access to ophthalmic care enhances force readiness because ocular trauma and disease can cause vision impairment or blindness and can occur anywhere Service Members are located. Recently, a secure, Health Insurance Portability and Accountability Act-compliant mobile phone application (app) for teleophthalmology called Forward Operating Base Expert Telemedicine Resource Utilizing Mobile Application for Trauma (FOXTROT) was beta tested in Afghanistan and demonstrated that this solution can improve and extend ophthalmic care in a deployed environment. There are few civilian or military teleophthalmology solutions for ocular trauma and disease in an urgent or emergent ophthalmic care setting. Civilian teleophthalmology solutions have largely been developed for disease-specific models of care. In this work, we address this gap by testing the FOXTROT app in a non-deployed, emergent care setting.

Materials and methods: We evaluated the use of the teleophthalmology mobile phone app (FOXTROT) in a non-deployed military setting at the Malcolm Grow Medical Clinics and Surgery Center at Joint Base Andrews in Maryland. Consults from the emergent care center were placed by providers using the app, and the on-call ophthalmologist responded with treatment and management recommendations. The primary outcomes were response within the requested time, visual acuity tested in both eyes, agreement between the teleophthalmology and the final diagnosis, and the number of communication or technical errors that prevented the completion of consults. The secondary outcomes were average response time and the number of consults uploaded to the medical record.

Results: From October 2020 to January 2022, 109 consults were received. Ten consults had communication or technical errors that prevented the completion of the consults within the app and were excluded from the analysis of completed consults. Of the 99 completed consults, responses were given within the requested time in 95 (96.0%), with the average response time in 11 minutes 48 seconds (95% confidence interval, 8 minutes 57 seconds to 14 minutes 41 seconds). Visual acuity was tested in both eyes in 56 (56.6%). There was agreement between the teleophthalmology diagnosis and the final diagnosis in 40 of 50 (80.0%) consults with both a teleophthalmology and final diagnosis. Ninety-eight (99.0%) consults were uploaded to the patient's medical record.

Conclusions: Beta testing of a teleophthalmology mobile phone app (FOXTROT) in a noncombat emergent care setting demonstrated that this solution can extend ophthalmic care in this environment at a military treatment facility. However, improvements in the reliability of the platform are needed in future developments to reduce communication and technical errors.

Studying the effect of sensor visualization and graphical augmentation on obstacle detection time in the low altitude flight environment.

Article published in *Forum 79 – Vertical Flight Society Proceedings*, 2023.
DOI: Not applicable (N/A)

By Flanigen, P., Wilson, M., Sarter, N., & Atkins, E.

Obstacle strikes are only behind controlled flight into terrain as the known cause of fatal civilian helicopter accidents. Failing to notice obstacles is also a leading cause of military rotor craft mishaps. This can be explained, in part, by the fact that aircrews must quickly notice and locate a wide variety of hazards, including vertical obstacles while performing various other flight-related tasks. This need for divided attention calls for the development of better bottom-up support for obstacle detection through display design. To this end, the present study will employ a within-subjects design to assess the efficacy of visualization types (unaided, image intensification, or thermal imaging) and obstacle augmentation approaches (none, a priori circles, or active sensor boxes around the obstacle) for aiding hazard awareness and avoidance. Performance and eye tracking data, verbal behavior, and qualitative feedback will be collected to assess pilots' ability to balance vital aircraft state awareness with timely perception of obstacles in the low altitude flight environment. Ultimately, the results from this study will contribute to the literature in visual attention and interface design, potentially increasing safety during helicopter flight operations.

Head flail corridors from sled impact acceleration tests for use in occupant-centric vehicle design.

Article published in American Society of Mechanical Engineers (*ASME) International Mechanical Engineering Congress and Exposition (IMECE) Proceedings*, 2023.
DOI: 10.1115/IMECE2022-89198

By Olszko, A. V., Abraczinskas, A. M., McGovern, S. M., Robinette, A. M., Vasquez, K. B., Chancey, V. C., & Brozoski, F. T.

This work presents some of the challenges and solutions identified when using a historical collection of high-speed film from human research volunteer and anthropomorphic test device sled tests to define corridors for head flail kinematics. Challenges were related to film "jitter" and a lack of information about timing, test setups, and camera position. The challenges were addressed for a set of 939 tests using digitized high-speed film and minimal additional information for calculating head displacement, scaling, and translating to the seat origin. The method produced realistic head displacement data from tracked phototarget data. For the

scaling method, the expanded uncertainty of measuring the phototarget size ranged from ±2.6 to ±3.7 pixels at a 95% confidence level. For the seat origin translation method, the average difference between calculated and actual seat origins was 6.6±5.0 centimeters (cm). The methods implemented in this work can inform future work leveraging tracked kinematic data from this and other historical biodynamics datasets, especially large datasets that require batch processing.

Video verification of an instrumented mouthguard in American collegiate men's rugby.

Article published in *ASME International Mechanical Engineering Congress and Exposition Proceedings*, 2023.
DOI: 10.1115/IMECE2022-94439

By Fetchko, T., Boudreau, G., Roach, M., Cameron, K., & Rooks, T.

There are few published studies investigating wearable head impact sensors that focus on rugby. Devices mounted externally on the head can shift or be fully removed during normal play. Investigation into the use of instrumented mouthguards in rugby has recently begun. However, different devices and their associated software have varying reliability in helmeted versus non-helmeted sports, which must be verified. This study implemented the Impact Monitor Mouthguard device in male American collegiate rugby players and used video-verification to assess the reliability of the device's validity software. We found a positive predictive value of 97.0%, which compares favorably to previously published values for this device. We believe this is the first study to analyze the accuracy of sensor events rejected by the software, which resulted in a negative predictive value of 97.0%.

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Technical Reports

USAARL-TECH-TR--2023-01. **The feasibility of operator state monitoring in Army aviation: A survey of subject matter experts.** October 2022. AD1182992

By Wilkins, J., Feltman, K., & Aura, C.

The U.S. Army's future vertical lift (FVL) program is developing a new fleet of aircraft that is set to replace the UH-60 Black Hawk and the AH-64 Apache. These new aircraft will include autonomous systems and have increased capabilities of speed, maneuverability, and operational range. With this increase in capability, there will be an increased overload in aviators' cognitive state leading to mishaps and accident fatalities. Operator state monitoring through psychophysiological indices and biomarkers are used to identify cognitive states. Subject matter experts completed two rounds of a Delphi-style survey to determine the reliability of selected sensors and biomarkers when incorporated in aviator operational environments.

USAARL-TECH-FR--2023-02. **Rotary-wing airworthiness certification and evaluation of the Athena GTX wireless vital signs monitor.** October 2022. AD1186072

By Eshelman, R. E., & Leach, G.

USAARL-TECH-FR--2023-03. **Preliminary evaluation of an osteopathic manipulative treatment (OMT) to prevent motion sickness symptoms.** October 2022. AD1186073

By Kelley A., Thomas, V., Lee, A. J., Fotopolous, T., Boggs, J., & Campbell, J.

Motion sickness directly impacts the readiness of the Army’s aviation units. Severe motion sickness results in the dismissal of pilot and aircrew candidates during initial training, while minor to moderate symptoms can be distracting during flight. The current medications on the market that target motion sickness symptoms are prohibited for use before flight. Osteopathic manipulative techniques are a low to no cost option, which lacks side effects, which allows Doctor of Osteopathic Medicine flight surgeons the opportunity to treat crewmembers without the use of pharmaceuticals. If effective, these techniques could be used alongside current desensitization training in order to ensure more pilot and crew candidates are eligible for flight. Given the paucity of research on such a technique, we conducted a small pilot study to evaluate the effectiveness of a novel osteopathic manipulative treatment to prevent motion sickness symptoms whilst controlling for motion

sickness susceptibility. The results of this study suggest that OMT may be effective at preventing motion sickness symptoms, specifically gastrointestinal (e.g., nausea) and sopite-related (e.g., drowsiness) symptoms. The effects observed were moderated by motion sickness susceptibility but not to the extent to suggest limited utility. The limitations of the study, however, preclude firm recommendations for operational use at this time.

USAARL-TECH-TR--2023-04. **A literature review of applied cognitive workload assessment in the aviation domain.** October 2022.
AD1186074

By Vogl, J., Delgado-Howard, C., Plummer, H., McAtee, A., Hayes, A., Aura, C., & St. Onge, P.

Advancements in technology have pushed the standard unit of work from the joule to the byte, as operators are tasked with increasing cognitively demanding information processing in domains such as transportation, warfighting, and medicine. Due to these advancements, interest in the field of cognitive workload and its assessment in applied environments has grown exponentially over the last two decades. Operator state monitoring systems promise to use performance, physiological, and subjective cognitive workload assessment metrics to predict when operators are approaching or experiencing cognitive overload and the system will take remedial action. A systematic literature review was conducted to survey the last decade (2010-2020) of cognitive workload assessment literature in the aviation domain. The objective of the literature review was to identify cognitive workload assessment techniques that have seen success in the aviation domain and examine the usability of composite cognitive workload metrics in an operational use case. Articles were obtained from three databases using keywords that surveyed cognitive workload terminology, measures, and domains.

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USAARL-TECH-FR--2023-05. **Surgical interventions for cervical intervertebral disc disease in U.S. Army aviators: A comprehensive review and identification of knowledge gaps.** November 2022.
AD1186076

By Madison, A. M., Stewart, A. S., Robinette, A. M., Sous, S. N., Yoganandan, N., & Chancey, V. C.

Two common cervical spine surgical intervention procedures (CSSIPs) for treating patients with severe cervical spine intervertebral disc disease (CIDD) are anterior cervical discectomy and fusion (ACDF) and cervical disc arthroplasty (CDA). Most medical guidelines regarding ACDFs and CDAs are based on general population health, activities, and life expectancy. Presently, knowledge gaps exist related to CSSIPs in the context of operational activities of military personnel who are frequently exposed to more dynamic and physically demanding scenarios than the general population. Currently, military guidelines consider ACDF and CDA disqualifying conditions for military fitness. This work presents the results of a robust literature review updating the state of knowledge regarding CSSIPs used for the treatment of CIDD and their applicability to the U.S. military rotary-wing environment.

USAARL-TECH-SR--2023-06. **Surgical interventions for cervical intervertebral disc disease in U.S. Army aviators: Recommendations to address gaps for improved medical readiness, retention, and endurance.** November 2022.
AD1187776

By Madison, A. M., Stewart, A. S., Robinette, A. M., Sous, S. N., Yoganandan, N., & Chancey, V. C.

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USAARL-TECH-SR--2023-07. **En route care in confined spaces: Medic posture assessment.** November 2022.
AD1187782

By Lloyd, A. L., Kinsler, R. E., Caruso, K., Kroening, L. R., Dupuy, J., & Molles, J.

The confined space of common medical evacuation (MEDEVAC) configurations requires strenuous positions and painful postures of critical care flight paramedics (CCFPs) during patient loading and unloading during en route care. The goal of this study was to identify areas for design improvements or loading techniques to limit awkward or painful postures experienced by the CCFP that may lead to injury or musculoskeletal disorders (MSD). A total of 17 human subjects participated in the study. The subjects were healthy members of the U.S. Army, Reserve, and/or National Guard. Subjects were be dressed in full gear and markered to track body movement. Markers were placed on the head, torso, left arm, and left leg. Before motion trials began, a static trial captured the subject's standing posture. Ten motion trials were be conducted. Six trials were recorded loading and unloading manikins onto the Basic Medical Interior (BMI) and four trials were recorded using the Interim MEDEVAC Mission Support System (IMMSS). Motion data was captured and analyzed to calculate the kinematics of the subject's major body segments. The simulated medic's posture was be investigated to identify potentially dangerous postures that are known to lead to injury or MSD. Force estimates were calculated on the data to estimate the force at the L5/S1 vertebral disk.

USAARL-TECH-TR--2023-08. **Defining flight tasks and outcome measures: Results of an expert panel.** November 2022.
AD1187786

By Sharma, K., & Feltman, K. A.

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USAARL-TECH-TR--2023-09. **Overview of the aeromedical psychology training course.** November 2022.
AD1187788

By Sharma, K.

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USAARL-TECH-FR--2023-10. **Efficacy of medical device alarm integration into a simulated H-60 integrated communication system.** November 2022.
AD1188581

By Kroening, L. R., Kinsler, R. E., Molles, J. J., & Lloyd, A. L.

The objective of this study was to evaluate the efficacy of incorporating audible medical device alarms into a simulated aircraft Intercommunication Set (ICS). The effect of integrating these alarms on care provided and time delegation was examined. Subjective data was also collected from the Subjects regarding the benefits, drawbacks, and improvements they recognized during participation.

Subjects performed patient care tasks for two 30-minute scenarios. Each scenario had two priority-level patients, which were preprogrammed to have four decompensation events each. During one configuration the audio alarms were integrated into the Subject's ICS, and the other was non-integrated (the current standard). Testing took place in an HH-60 simulator with a BMI litter system. The Subjects were given all supplies in the current medical equipment set (MES) and given time to configure the interior of the simulated aircraft as they normally would. The patients were simulated with SimMan3G manikins, which displayed vitals on Zoll Propaq MD patient monitors via a Dynasthetics VitalsBridge 300. Subjects wore an HGU-56P helmet with Communication Ear Plugs (CEPs). Medical device alarms were integrated into the subject's CEPs via a custom-built ICS system equivalent, and all audio levels were measured prior to testing.

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USAARL-TECH-TR--2023-11. **A systematic literature review of operator state detection using physiological measures.** December 2022.
AD1188582

By Duffy, M. J., & Feltman, K. A.

A systematic literature review was conducted to examine the literature (published between 2010 and 2021) surrounding the use of physiological measures to identify operator's cognitive state. operator states of interest were those that pose significant risks to Army aviators. Specifically, workload, fatigue, inattention, stress, and hypoxia. Additionally, studies that took place in applied and/or mobile contexts were sought in order to ensure the greatest likelihood of operationally relevant work. From this review, thirty-two eligible studies were identified. From these studies, it was determined that workload, fatigue, and inattention show the greatest promise for detection through physiological metrics. However, this is in part due to number of available studies. For instance, only one study was eligible where hypoxia was the cognitive state of interest. Additionally, based on the papers reviewed, electroencephalogram (EEG) and eye metrics appear the most promising for identifying these various operator cognitive states. Further work is needed to validate some of these measures within true operational contexts. Specifically, based on the literature to-date, it is unknown how well some of these measures would hold up in a rotary-wing environment, where the sensors would be exposed to vibration and extreme temperatures. Further work is needed to determine whether the findings from these papers generalize to a larger population.

USAARL-TECH-AR--2023-12. **USAARL fiscal year 2022 annual historic report.** January 2023.
AD1190586

By USAARL Science Information Center

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USAARL-TECH-FR--2023-13. **Unmanned aerial systems (UAS) operations from the operators' perspective: 2022 survey responses**. January 2023.
AD1192852

By Jones, H.

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USAARL-CNPA-BC--2023-14. **The effects of hypoxia and ocular fatigue on dynamic stereoscopic depth tracking.** February 2023.
AD1196942

By Temme, L.

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USAARL-TECH-TR--2023-15. **A systematic review of the transcranial electrical stimulation literature for performance enhancement.** February 2023.
AD1197229

By D'Alessandro, M., Feltman, K., Wilkins, J., & Boggs, J.

> The purpose of this report is to update a previous review on the neuromodulation technologies of transcranial magnetic stimulation and transcranial electrical stimulation (Kelley et al., 2019). Ongoing work within the U.S. Army is investigating means of sustaining or enhancing Soldier performance. As neuroenhancement is a rapidly evolving field, it is imperative to stay up-to-date on the current state of the science. As such, this report includes studies performed between 2018 and 2022 that met our specific inclusion criteria. This report specifically focuses on studies that investigate the potential role for the neuromodulation technologies of transcranial magnetic stimulation (tMS) and transcranial electrical stimulation (tES) to enhance cognitive function. In particular, we are interested in several specific aspects of cognition that relate directly to the daily function of the Soldier including working memory, attention, inhibition, cognitive control, and reasoning/decision making. Here, we have discussed the feasibility and practicality aspects of implementing this technology in the military setting as well as the current limitations and remaining questions within the research field of transcranial stimulation pertaining to enhancing cognitive performance.

USAARL-TECH-TR--2023-16. **Evaluation of inter-subject variability in physiological metrics and workload perception: Implications for operator state monitoring.** February 2023.
AD1197230

By Kelley, A., McAtee, A., Duffy, M., & Feltman, K.

Incorporation of operator state monitoring through non-invasive psychophysiological metrics would enable an objective assessment of the operator's cognitive state in real-time. Realization of such an endeavor would translate to the ability to develop adaptive automation that tailors the level of automation based on the operator's current cognitive state, as well as the ability to provide leadership with up-to-date information on the crew's cognitive state. However, while much of the work completed to-date has yielded promising results, a key obstacle remains: Accounting for individual variability. This study analyzed archival data from four studies assessing physiological measures, individual differences, and cognitive workload. Minimal support for relationships between individual differences and workload levels was identified. Of those evaluated, abstract reasoning, state anxiety characteristics, and depression symptoms correlated with workload but not consistently across the four studies' datasets analyzed. With respect to physiological measures and workload, the findings show a number of physiological variables that consistently appeared as top predictors in identifying workload condition. Further research is needed to examine additional individual difference measures that may contribute to changes in physiological response from workload manipulations.

USAARL-TECH-TR--2023-17. **Impact of transport forces and immobilization practices on patient physiology: Evaluate effect of strapping tension.** February 2023.
AD1197232

By Lloyd, A., Kinsler, R., Caruso, K., Kroening, L., & Molles, J.

The goal of the study was to evaluate how litter strap tension affects patient biodynamics during transport. The hypothesis that strap tension has significant effects on transmitted vibration during transport was tested during three phases of testing. In Phase 1, standard tension practices were observed by having medics strap a manikin to a litter. This phase determined average litter strapping tension. Phase 2 consisted of test setup validation using an instrumented vibration manikin. The simulated patient manikin was tested on a ride simulation platform in several configurations while vibration data was collected. In Phase 3, data was collected using 25 human subject participants with varying body weights. The weight of each participant was between 102 and 275 pounds. The human subject participants were secured to a litter on the ride simulator and subjected to multiple vibration profiles. The level of strap tension did significantly affect the biodynamics of the

supine patient. The effects of strap location and strap tension varied by segment because of the difference in strap proximity to and placement on each segment. Results from this project will provide significant information and strategies that can be used toward increasing patient safety, reducing discomfort, and developing vibration mitigation systems.

USAARL-TECH-FR--2023-18. **En route care in confined spaces: Loading and unloading effect on patients.** March 2023.
AD1197233

By Kinsler, R., Caruso, K., Lloyd, A., Kroening, L., & Molles, J.

The purpose of this study was to characterize the biodynamic response of a supine human during the loading and unloading procedures on a MEDEVAC aircraft. An instrumented manikin with accelerometers and gyroscopic sensors replicated the human biodynamic response to vibration and mechanical shock. Two platforms, the BMI on the HH-60 and the IMMSS on the UH-60 were used for testing. Other parameters were varied throughout the study including loading height, loading direction (head-first versus feet-first), and litter pole sensor placement (inboard versus outboard). Results showed that loading the litter imparted significantly more vibrational exposure to the manikin than walking the litter. There were no significant differences in vibratory exposure between the two MEDEVAC platforms. No significant difference was also observed when comparing loading the manikin head-first versus feet-first, or when comparing loading at the top height versus the bottom height within the platforms. This study indicates that litter loading and unloading procedures result in statistically significant exposure to vibratory motions and may result in exacerbating casualty injury. Aircraft design and litter bearer training may help reduce some exposure to these motions.

USAARL-TECH-TR--2023-19. **Head mounted display guidelines for future vertical lift.** March 2023.
AD1197234

By Harding, T., & McLean, W.

This report contains recommendations for helmet mounted displays in future vertical lift aircraft.

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USAARL-TECH-FR--2023-20. **Predicting head flail response to impact acceleration using historical human volunteer data and a velocity-based linear regression approach.** March 2023.
AD1197243

By Olszko, A., McGovern, S., Abraczinskas, A., Robinette, A., Vasquez, K., Chancey, V. C., & Brozoski, F.

Models used for predicting head flail response were developed using an existing collection of human research volunteer (HRV) test data from the Naval Biodynamics Laboratory collection within the Biodynamics Data Resource (BDR) of the U.S. Army Aeromedical Research Laboratory. Verification and validation were completed for the response models for frontal, axial, and lateral impact directions. The response models were verified to accurately predict the HRV response used to develop the model. The response models were validated to accurately predict the anteroposterior (AP), lateral, and vertical displacements for BDR HRV tests with similar boundary conditions but different input parameters than those of the BDR HRV tests used to develop the response model. The response models were not shown to be valid for predicting subject responses to higher sled acceleration levels and velocity changes found in literature. The primary reason for this is the differences in initial and boundary conditions between the NBDL dataset and the datasets from literature.

USAARL-CNPA-BC--2023-21. **Evaluating operator state using eye tracking and pupillometry in rotary-wing pilots during simulated flight.** March 2023.
AD1197273

By Aura, C., Yue, X., Basso, J., Mathews, C., Maldonado, F., Wilkins, J., & Feltman, K.

Flight operations in degraded visual environments (DVE) pose significant risks to the aviators completing those operations. DVE occurs when an aviator is exposed to partial or total loss of visibility due to environmental factors, such as airborne dust, sand, or snow, as well as clouds, haze, fog, and starless nights. The implementation of advanced flight controls, sensors, and cueing delivered via the visual, auditory, and tactile senses has promise to mitigate the risk of accidents and mishaps in such conditions. USAARL researchers recently completed a study evaluating the Integrated Cueing Environment (ICE) developed by U.S. Army Combat Capabilities Development Command researchers. Eye tracking was conducted to reveal how the pilot visually interacts with the symbology, and to assess arousal, autonomic tone, and potentially, cognitive workload, while they engage in the flight tasks.

Presented at Aerospace Medicine Association's Annual Conference in 2023.

USAARL-TECH-TR--2023-22. **Direct comparisons of eye tracking data loss between systems utilizing three common camera mounting configurations in a UH-60M Black Hawk simulator.** March 2023.
AD1198156

By Aura, C., Yue, X., Andres, K., & Feltman, K.

> Performance comparison of eye tracking camera systems, by mounting configuration, in the UH-60M cockpit layout.

USAARL-TECH-TR--2023-23. **Rotary-wing airworthiness certification and evaluation of the Inovytec Medical Solutions Ltd., Ventway Sparrow VWSP-900 Robust Model.** March 2023.
AD1198161

By Eshelman, R., Black R., Leach, G., & Estes, Z.

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USAARL-TECH-TR--2023-24. **Rotary-wing airworthiness certification and evaluation of the AutoMedx, Incorporated SAVe II+.** February 2023.
AD1199696

By Eshelman, R., Black, R., Leach, G., & Estes, Z.

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USAARL-TECH-TR--2023-25. **Rotary-wing airworthiness certification and evaluation of the Butterfly Network Incorporated, Butterfly iQ+™ and General Electric Vscan Air™ CL ultrasound devices.** May 2023.
AD1202276

By Eshelman, R., Adaway, C., Black, R., & Estes, Z.

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USAARL-TECH-FR--2023-26. **Comparison of whole-body vibration biodynamics between healthy human subjects and injured swine models subjected to the similar ground medical evacuation transports.** June 2023.
AD1210134

By Kinsler, R., & Lloyd, R.

The overall objective of this project was to compare data sets from studies using healthy human subjects and studies using injured animal models subjected to similar ground transport insults to determine feasibility and suitability of using the injured animal model as a reasonable approximation for an injured human patient during ground medical evacuation transport. The biodynamic response of the swine model and the biodynamic response of a healthy human model exhibit similar patterns to the same ground ambulance excitations. Anthropometric measures, root-mean-square acceleration analyses, power spectral density calculations, and transmissibility calculations from each study were provided. Examination of the data and comparison of the swine with an existing supine human model for whole body vibration response indicates it is reasonable to conclude that swine is an acceptable model for the biodynamic response of humans subjected to ground transport if appropriate scaling factors can be defined and applied.

USAARL-CNPA-BC--2023-27. **The U.S. Army Aeromedical Research Laboratory virtual reality vection system.** August 2023.
AD1210139

By Temme, L., & Nagy, R.

This presentation describes and documents the USAARL virtual reality vection system (VRVS), a versatile, inexpensive, tool to investigate and characterize vection as a form of spatial disorientation (SD). In aviation, SD refers to the potentially catastrophic situation in which a pilot fails to correctly understand the position, motion, direction, or attitude of the aircraft with respect to the Earth's surface. Vection is a form of SD that generates the feeling of movement in an individual who is not moving. Since vection can be reliably generated under controlled laboratory conditions, it is a convenient model of SD. The VRVS is described, including its components, software, hardware, and user interfaces. Tests and evaluations conducted while creating the VRVS demonstrate that the system reliably provokes vection-based SD. The VRVS includes two complementary methods for quantifying the presence and magnitude of the vection illusion. The VRVS enables the simultaneous measurement of vection as well as symptoms of cybersickness.

Poster presented at the Military Health System Research Symposium, 14-17 August, 2023 in Kissimmee, FL.

USAARL-CNPA-BC--2023-28. **The response slider: An inexpensive, microprocessor controlled linear potentiometer for acquiring multivariate magnitude estimation data.** August 2023.
AD1210142

By Nagy, R., Meredith, K., O'Brien, K., & Temme, L.

The present report describes and documents a component of the USAARL VRVS. The VRVS is a versatile, inexpensive, tool designed to investigate and characterize vection as a model of SD. In aviation, SD refers to the potentially catastrophic situation in which a pilot fails to correctly understand the position, motion, direction, or attitude of the aircraft with respect to the Earth's surface. Vection is a form of SD that generates the feeling of motion in an individual who is not moving. Since vection can be reliably generated under controlled laboratory conditions, it is a convenient model to study, characterize, and demonstrate SD. The response slider is designed to record a measure of estimated vection magnitude as a function of stimulus duration.

Poster presented at the Military Health System Research Symposium, 14-17 August, 2023 in Kissimmee, FL.

USAARL-CNPA-BC--2023-29. **Retinal structural integrity and visual field function in patients with mild traumatic brain injury (mTBI).** August 2023.
AD1210145

By Trinh, T., & Viswanathan, S.

The visual system is vulnerable to traumatic brain injury. Optical coherence tomography (OCT) is an objective, non-invasive imaging technology to capture and evaluate ocular structures with precision and high resolution. Also, standard automated perimetry (SAP) is widely used to screen and manage afferent disorders, including optic nerve conditions. The purpose of this study was to evaluate optic nerve, macular thickness, and visual field functions in patients with chronic mTBI. The peripapillary retinal nerve fiber layer (pRNFL) and macular thickness were measured using the High-resolution Angiography Spectralis from Heidelberg Engineering. Standard automated perimetry was assessed using the Humphrey Field Analyzer from Carl Zeiss Meditec with Swedish Interactive Threshold Algorithm. The study found a reduction in the global pRNFL and visual field sensitivity and their deviation from age-expected values in patients with chronic mTBI compared to age-matched, healthy controls suggest that OCT and SAP can be utilized to assist in monitoring neurodegeneration and functional deficits after mTBI. Alterations in the axoplasmic flow in the prelaminar and post-laminar optic nerve may lead to thinning of the peripapillary RNFL. The reduction in the RNFL thickness could be a structural biomarker of the neurodegeneration after mTBI.

Poster presented at the Military Health System Research Symposium, 14-17 August, 2023 in Kissimmee, FL.

USAARL-CNPA-BC--2023-30. **The effects of simulated hearing loss on aviator performance and cognitive workload during simulated flight.** August 2023. AD1210149

By Jones, H., Hale, K., Lee, K., Henry, P., Stefanson, JR, Mackie, R., & Noetzel, J.

Army aviators require a level of hearing acuity to communicate in high operational tempos, which includes the use of multiple radios while performing flight operations. Military operations, including rotary-wing aircraft noise, present short-term risks to the communication abilities of Army aircrew and long-term risks to aviator hearing health in the form of hearing loss, which can be temporary or permanent. Hearing loss can render an aviator more susceptible to the adverse effects of degraded communication signal quality and consequently lead to an increased allocation of mental resources to hear, referred to as 'listening effort.' Army aviation hearing standards, which are primarily based on pure tone testing and speech recognition scores in quiet, do not necessarily predict the functional impact of hearing loss. Given this, the current study aimed to first determine the scope of hearing loss in Army aviators over the past five years and analyze the impact of current threshold requirements on in-flight performance data from pilots presented with simulated hearing loss.

Poster presented at the Military Health System Research Symposium, 14-17 August, 2023 in Kissimmee, FL.

USAARL-CNPA-BC--2023-31. **Evaluating the suitability for eye tracking in simulated rotary-wing flight simulators.** August 2023. AD1210151

By Aura, C. J., Yue, X., Andres, K., Wilson, M., & Feltman, K.

Eye tracking is gaining favor in operator state monitoring (OSM) in that it provides non-invasive access to arousal, autonomic tone, neurological condition, and potentially, cognitive workload by recording changes in pupil diameter and eye movement dynamics. However, the operational environment of rotary-wing aviation has unique challenges to effective eye tracking, such as uncontrolled luminance changes, exposure to vibration, and more physical movement by the aviator than is typical in fixed-wing and ground vehicle systems. Developments in eye tracking technology have enabled researchers to achieve better access to human subjects' behavior in a wider range of settings, potentially allowing the assessment of cognitive workload, fatigue, and changes in autonomic function in military operational settings. Many different eye tracking systems are currently available. These can be broadly categorized by configuration as remotely mounted multi-camera arrays, remotely mounted single cameras, and head-mounted

camera arrays. These different configurations each have their own pros and cons. To date, no comparison between these different systems has been completed to determine which configuration is most suitable for a cockpit environment. Here, we present findings from studies of workload supporting the scientific validity of eye tracking variables for consideration in OSM as well as findings from an evaluation of different configurations in a simulated cockpit.

Approvals: This presentation reports human research reviewed and approved by the Headquarters, U.S. Army Medical Research and Development Command Institutional Review Board, and separate data sets collected from activities determined to not qualify as human subjects research by the USAARL determination official.

In our continued efforts to develop and expand USAARL's eye tracking capabilities and appraise the suitability for eye tracking in operational settings, we have recently conducted a direct comparison of the performance of three eye trackers in a flight simulator. Eye camera systems with three unique mounting configurations were evaluated sequentially by rated aviators (n = 5) while they performed a choreographed sequence of fixations around the cockpit, followed by an overland flight. These were completed in the Cockpit Academics Procedural Tool –Enhanced Visual Capable System (SGB-Enterprises, CA, USA) fixed-base UH-60M flight simulator. This simulator was constructed for USAARL by combining it with a 12-foot projection dome (Q4 Services, CA, USA) and X-IG image generation software (CATi Systems, AL, USA). The eye tracking systems evaluated included one with a single camera mounted remotely on the dashboard directly in front of the pilot, another with five cameras mounted remotely in locations spread throughout the cockpit, and the last with small cameras fixed to a frame worn on the head (like eyeglasses).

Results: All three systems were able to collect data with some success and support the inclusion of eye tracking in operationally viable operator state monitoring systems. In addition, a survey of experts in the fields of physiology, psychology, and human performance rated the extent to which various physiological measures may be useful in OSM, and more specifically, predicting cognitive workload. With respect to eye tracking, 76.1% of respondents to the relevant survey questions (total respondents = 21) rated these measures as "likely" or "very likely" able to detect changes in cognitive workload. 72.7% of these respondents also reported that changes in cognitive workload can be detected using pupillometry, or the measurement of changes in pupil size. These responses are supported with data collected by USAARL researchers demonstrating that increases in pupil diameter are associated with increasing cognitive challenge (Aura et al., 2021) on an *n*-back sequential memory task.

Discussion: A direct comparison of the performance of multiple eye tracking systems found that modern eye tracking systems (configurations: Multi-camera,

head-mounted) can perform at an acceptable level within the unique mounting constraints of the UH-60M cockpit layout. As the simulator used in this activity was fixed, and did not have motion capability or simulated vibration, we cannot yet determine how these systems will tolerate those additional forces. Future efforts are underway to conduct a second phase of testing to address the impact of these forces in a full-motion simulator. This is supported by significant pupillometric effects found in prior USAARL research efforts looking at eye tracking metrics and direct manipulations of cognitive workload (Aura et al., 2021). In addition, most of the survey respondents support including eye tracking and pupillometry in future, multi-modal, physiological operator state monitoring suites. In summary, eye tracking remains an integral part of USAARL's research surrounding operator state monitoring. As we learn more on the feasibility of including eye tracking systems in efforts moving closer the operational environment, we will continue to provide U.S. Army decision-makers with recommendations for future vertical lift projects.

USAARL-TECH-TR--2023-32. **An assessment of the limitations of night vision goggles (NVGs) in high-speed terrain flight.** September 2023.
AD1210156

By Curry, I., Sullivan, C., Mackie, R., & Sharma, K.

A test was conducted in the vertical motion simulator (VMS) at Ames Research Center, California to assess the ability of Army pilots to conduct high speed, low-level and contour flight using a tilt rotor aircraft model. During this test, six pilots conducted more than 300 test runs over flat, rolling, and mountainous terrain at airspeeds from 120-220 knots in both day and NVG conditions. Performance was judged by two primary metrics: Time spent above the doctrinally established threshold altitude as a percentage of total time for a test run and number of ground/obstacle strikes during each run. Within the limited scope of this test effort, it was determined that high speed (up to 220 knots), low-level flight was possible in all terrain types in both day and NVG conditions. High speed contour flight was possible in flat terrain; however, high speed contour flight in rolling or mountainous terrain was not possible without significant risk of ground/obstacle contact or significant time spent above contour altitude. In all cases, optimal NVG conditions (full moon illumination) produced essentially the same results as day conditions.

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USAARL-TECH-FR--2023-33. **U.S. Army Aeromedical Research Laboratory Editorial Guide.** September 2023.
AD1212090

By Science Information Center

This editorial guide provides USAARL personnel with guidance for preparing technical reports and memoranda. This guide also summarizes information regarding publishing in the open literature. With the publishing of scientific material, a standardized publication style is important and necessary. This editorial guide and the examples in it, give USAARL personnel a single, readily available source for answers to questions that may arise when writing technical documents.

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Technical Memorandums

2023-01. **FVL performance envelope; implications for aircrew physiology and performance.** 10 October 2022.

Delivered to: Cross Functional Team Future Vertical Lift

Technical Point of Contact (POC): Ian Curry

2023-02. **Assessment of the remote control and monitoring capabilities of the Athena GTX automated critical care system.** 20 October 2022.

Delivered to: U.S. Army Telemedicine & Advanced Technology Research Center

Technical POCs: Rachel Kinsler, David Jones

2023-03. **Assessments of degraded visual environment symbology concepts, situational awareness, and workload in psycho/physiologically stressed aircrew.** 28 October 2022.

Delivered to: U.S. Army Aeromedical Research Laboratory (Science Program Director)

Technical POC: Michael Wilson

2023-04. **Test results for the airworthiness test and evaluation of the Vita Rescue System – Litter Attachment.** 17 January 2023.

Delivered to: Utility Helicopter Project Office, MEDEVAC Product Office

Technical POC: Caitlin Lawson, David Jones

2023-05. **Test results for the hemorrhage detection devices.** 30 January 2023.

Delivered to: U.S. Army Medical Materiel Development Activity, Warfighter Expeditionary Medicine, and Treatment

Technical POC: Bob Eshelman, David Jones

2023-06. **Test results for the Cascade Rescue StableFlight Helibag.** 31 March 2023.

Delivered to: Product Director MEDEVAC

Technical POCs: Vince Fralish, David Jones

2023-07. **Limited test results for the Physical Sciences, Incorporated Rapid Emergency Evacuation Litter.** 5 April 2023.

Delivered to: U.S. Marine Corps System Command, Program Manager, Supply & Maintenance Systems

Technical POCs: David Jones

2023-08. **Field evaluation of operator state monitoring sensors worn during normal helicopter flight operations.** 12 April 2023.

Delivered to: U.S. Army Aeromedical Research Laboratory

Technical POC: Paul St. Onge

2023-09. **Limited airworthiness testing of the Starix Technology Ultra-wideband medic radio.** 4 August 2023.

Delivered to: Mr. Frederick Battaglia, Starix Technology, Inc.

Technical POC: Vince Fralish

2023-10. **Physiological findings for V6.5 Human Factors Evaluation Event.** 15 August 2023.

Delivered to: U.S. Army Development Command Aviation and Missiles Center Systems Readiness Directorate, Apache Fielding and Modernization Branch Chief

Technical POC: Katie Feltman

2023-11. **Test results for rotary-wing airworthiness certification and evaluation of the International Biomedical, Airborne® Voyager transport incubator.** 26 September 2023.

Delivered to: U.S. Army 2nd Combat Aviation Brigade, Eighth United States Army, Camp Humphreys, Republic of Korea

Technical POC: Robert Eshelman

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Oral Presentations

Berthelson, P., McMahon, J., Shah, A., Op 't Eynde, J., Salzar, R., & McEntire, B. J. (2023). *Comparison of preliminary behind armor blunt trauma-induced rib fracture risk for porcine cadavers and post-mortem human subjects* [Oral presentation]. Military Health Systems Research Symposium (MHSRS), Kissimmee, FL, USA.

Brozoski, F. T., Logsdon, K .P., Ganz, G. A. & Sous, S. N. (2022). *Evaluation of combat helmet fitting system modifications to improve blunt impact protection for flight medics* [Oral presentation]. 60th Annual SAFE Symposium, Mobile, AL, USA.

Campbell, J. (2023). *USAARL brief* [Oral presentation]. American Osteopathic College of Occupational and Preventative Medicine Conference, Kansas City, MO, USA.

Colon, J., Wilkins, J., & Jones, H. (2023). *Current perspective of UAS operators: 2022 survey responses* [Oral presentation]. UAS Summit, Fort Novosel, AL, USA.

Crowley, J. (2023). *Effect of future rotorcraft designs on aviator performance, aeromedical fitness standards, and aviation medicine* [Oral presentation]. Aerospace Medicine Association (ASMA), New Orleans, LA, USA.

Crowley, J. (2023). *Operational impact of technological advances in Army aircraft: What it means for flight surgeons in the future* [Oral presentation]. Aerospace Medicine Rapid Air Mobility/North Atlantic Treaty Organization (NATO) Science and Technology Organization (STO) Human Factors and Medicine (HFM)-364 Technical Course, Garmisch, Germany.

Crowley, J., & Sullivan, C. (2023). *Aeromedical aspects of the Army's future vertical lift program* [Oral presentation]. MHSRS, Kissimmee, FL, USA.

Feltman, K. (2022). *Neuroenhancement in military personnel: Conceptual and methodological challenges* [Oral presentation]. NATO STO-HFM-334 Symposium, Toronto, Canada.

Feltman, K., Aura, C., & Kelley, A. (2023). *Operator state monitoring for future vertical lift: Progress to-date* [Oral presentation]. Human Center of Gravity Meeting, Fort Novosel, AL, USA.

Feltman, K., Aura, C., & Kelley, A. (2023). *Operator state monitoring for future vertical lift* [Oral presentation]. MHSRS, Kissimmee, FL, USA.

Feltman, K., & Trinh, T. (2022). *Enhancing soldier performance with transcranial direct current stimulation (tDCS): Results of two studies* [Oral presentation]. STO-HFM-334 Symposium, Toronto, Canada.

Feltman, K., Wilkins, J., & Aura, C. (2023). *Psychophysiological monitoring for real-time cognitive state detection: A survey of experts* [Oral presentation]. Intelligent Human Systems Integration, Venice, Italy.

Fetchko, T. J., Boudreau, G., Roach, M. H., Cameron, K., & Rooks, T. F. (2022). *Video verification of an instrumented mouthguard in American collegiate men's rugby* [Oral presentation]. ASME 2022 IMECE, Columbus, OH, USA.

Flath, N. L., Lafferty, E. L., & McEntire, B.J. (2022). *Helmet mass simulation device: Static accuracy and motion induced error* [Oral presentation]. 60th Annual SAFE Symposium, Mobile, AL, USA.

Johnson, B.A., Logsdon, K. P., & McEntire, B. J. (2022). *A review of cervical spine injuries among occupants involved in rotary-wing aircraft mishaps from 1990 to 2018* [Oral presentation]. 60th Annual SAFE Symposium, Mobile, AL, USA.

Jones, H., Tasko, S., Deiters, K., Flamme, G., Smith, M., Murphy, W., Greene, N., & Ahroon, W. (2023). *Effects of unilateral eye closure on middle ear muscle contractions* [Oral presentation]. Midwinter Meeting for the Association for Research in Otolaryngology, Orlando, FL, USA.

Kelley, A., & Feltman, K. (2023). *Biomedical tools and techniques for maintaining and enhancing performance in future vertical lift aircrew* [Oral presentation]. MHSRS, Kissimmee, FL, USA.

Kelley, A., & Feltman, K. (2023). *Physiological indices to predict task performance and operator workload: A two-step approach to real-time state monitoring* [Oral presentation]. Intelligent Human Systems Integration, Venice, Italy.

Kelley, A., McAtee, A., Duffy, M., & Feltman, K. (2023). *Identification of individual differences for incorporation in operator state monitoring* [Oral presentation]. ASMA, New Orleans, LA, USA.

Kinsler, R. (2023). *En route care aspects of the future vertical lift program – An update from U.S. Army Aeromedical Research Laboratory* [Oral presentation]. MHSRS, Kissimmee, FL, USA.

Lloyd, A., Kinsler, R., Caruso, K., Kroening, L., & Molles, J. (2023). *En route care provider posture study* [Oral presentation]. ASMA, New Orleans, LA, USA.

Madison, A. M., Novotny, B. L., Ballard, M. T., Williams, S. T., Robinette, A. M., Stewart, A. S., & Chancey, V. C (2023). *Effects of assistive device use on carry distance and grip strength during simulated litter transport* [Oral presentation]. MHSRS, Kissimmee, FL, USA.

McEntire, B. J. (2023). *Protecting future vertical lift crew and passengers: New challenges and solutions* [Oral presentation]. MHSRS, Kissimmee, FL, USA.

McEntire, B. J. (2022). *Protecting future vertical lift crew and passengers – new challenges and solutions* [Oral presentation]. 60th Annual SAFE Symposium, Mobile, AL, USA.

McEntire, B. J., & Shender, B. (2022). *Collaborative effort to validate the USAARL acute injury head-supported mass curve* [Oral presentation]. 60th Annual SAFE Symposium, Mobile, AL, USA.

McMahon, J. A., Berthelson, P. R., Salzar, R. S., Shah, A., Op ‘t Eynde, J., & McEntire, B. J. (2023). *Development of impulse-based rib fracture injury criterion for behind armor blunt trauma* [Oral presentation]. 2023 International Research Council on Biomechanics of Injury-Europe, Cambridge, United Kingdom.

Noetzel, J. (2022). *Effects of hearing loss on aviator performance and workload* [Oral presentation]. 60th Annual SAFE Symposium, Mobile, AL, USA.

Olszko, A. V., Abraczinskas, A. M., McGovern, S. M., Robinette, A. M., Vasquez, K. B., Chancey, V. C., & Brozoski, F. T. (2022). *Challenges of using high-speed film from historical sled impact acceleration tests in the analysis of head flail kinematics* [Oral presentation]. ASME 2022 IMECE, Columbus, OH, USA.

Op 't Eynde, J., Shah, A. S., McMahon, J. A., Pang, D. Y., Stemper, B. D., Yoganandan, N., Salzar, R. S., McEntire, B. J., & Bass, C. R. (2023). *Scaling animal to human injury response for use in improved behind armor blunt trauma injury criteria* [Oral presentation]. Personal Armor Systems Symposium, Dresden, Germany.

Rhodes, D., & McEntire, B. J. (2022). *Critical review of injury assessment reference value applications in the military environment* [Oral presentation]. 60th Annual SAFE Symposium, Mobile, AL, USA.

Rooks, T. F. & French-Krahn, H. (2023). *Tether snatch heavy parachute operations health hazards study* [Oral presentation]. Joint Military Free Fall Working Group, Fort Novosel, AL, USA.

Rooks, T. F., Baisden, J. L., Chancey, V. C., & Yoganandan, N. (2022). *Regional strain response of an anatomically accurate non-human primate finite element brain model under frontal impact* [Oral presentation]. 2022 Association for the Advancement of Automotive Medicine 66th Annual Scientific Conference, Indianapolis, IN, USA.

Shah, A., McMahon, A., Op ‘t Eynde, J., Salzar, R., Johnson, B., & McEntire, B. J. (2023). *Data filtering for the analysis of biological tests for behind armor blunt trauma studies* [Oral presentation]. Personal Armor Systems Symposium, Dresden, Germany.

Shah, A. S., Yoganandan, N., Otterson, M. F., Stemper, B. D., Eynde, J. O., Bass, C. D., McMahan, J., Salzar, R. S., & McEntire, B. J. (2023). *A methodology to obtain injury and biomechanical data from live swine experimentation for behind armor blunt trauma* [Oral presentation]. Summer Biomechanics, Bioengineering and Biotransport Conference, Vail, CO, USA.

Shah, A., Yoganandan, N., Stemper, B., Humm, J., Koser, J., Bass, C. D., Salzar, R., Johnson, B. A., & McEntire, B. J. (2022). *Porcine skeletal and organ injuries for development of regional thoraco-abdominal injury criteria* [Oral presentation]. 60th Annual SAFE Symposium, Mobile, AL, USA.

Shah, A., Yoganandan, N., Stemper, B. D., Op 't Eynde, J., Bass, C., McMahon, J., Salzar, R., & McEntire, B. J. (2023). *Use of different types of biological human surrogates to develop regional tolerances for behind armor blunt trauma: Preliminary liver test results* [Oral presentation]. MHSRS, Kissimmee, FL, USA.

Temme, L. (2022). *The effects of hypoxia and ocular fatigue on dynamic stereoscopic depth tracking* [Oral presentation]. Military Operational Medicine Research Program Aviation Mishap Prevention Research Interim Progress Report.

Thomas, V., Kelley, A., Lee, A., Fotopoulos, T., Boggs, J., & Campbell, J. (2023). *Efficacy of osteopathic manipulative treatment to prevent motion sickness symptoms* [Oral presentation]. Association of Military Osteopathic Physicians and Surgeons Meeting, Orlando, FL, USA.

Wilkins, J., Aura, C., & Feltman, K. (2023). *Electroencephalography systems feasibility for FVL aircrew and operators* [Oral presentation]. MHSRS, Kissimmee, FL, USA.

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Poster Presentations

Aura, C., Yue, X., Andres, K., Wilson, M., & Feltman, K. (2023). *Evaluating the suitability for eye tracking in simulated rotary-wing flight simulators* [Poster presentation]. MHSRS, Kissimmee, FL, USA.

Aura, C, Yue, X., McAtee, A., Basso, J. Matthews, C., Maldonado, F., Wilkins, J., & Feltman, K. (2023*). Evaluating operator state using eye tracking and pupillometry in rotary-wing pilots during simulated flight* [Poster presentation]. ASMA, New Orleans, LA, USA.

Duffy, M., Sharma, K., Feltman, K., & Temme, L. (2023). *SME views of physiological variables for operator state monitoring in the FVL program* [Poster presentation]. MHSRS, Kissimmee, FL, USA.

Feltman, K., Basso, J., & Mathews, C. (2022). *Electrophysiological data and aviator performance: Identifying measures for operator state monitoring* [Poster presentation]. Human Factors and Ergonomics Society Annual Meeting, Atlanta, GA, USA.

Jones, H., Hale, K., Lee, K., Henry, P., Stefanson, JR, Mackie, R., & Noetzel, J. (2023). *The effects of simulated hearing loss on aviator performance and cognitive workload during simulated flight* [Poster presentation]. MHSRS, Kissimmee, FL, USA.

Nagy, R., Meredith, K., O'Brien, K., & Temme, L. (2023). *The response slider: An inexpensive, microprocessor controlled linear potentiometer for acquiring multivariate magnitude estimation data* [Poster presentation]. MHSRS, Kissimmee, FL, USA.

Rooks, T. F., Brown, B. A., Cunningham, S. M., Sullivan, C. C., Rosvold, E. M., Piehler, T., & Chancey, V. C. (2023). *Environmental sensors in training technologies at Project Convergence 2022: Demonstration of wearable sensors for head acceleration monitoring connected to Military Health System* [Poster presentation]. MHSRS, Kissimmee, FL, USA.

Temme, L., & Nagy, R. (2023). *The U.S. Army Aeromedical Research Laboratory virtual reality vection system* [Poster presentation]. MHSRS, Kissimmee, FL, USA.

Thomas, V., Kelley, A., Lee, A., Fotopoulos, T., Boggs, J., & Campbell, J. (2023). *Efficacy of osteopathic manipulative treatment to prevent motion sickness symptoms* [Poster presentation]. Association of Military Osteopathic Physicians and Surgeons Meeting, Orlando, FL.

Trinh, T., & Viswanathan, S. (2023). *Retinal structural integrity and visual field function in patients with mTBI* [Poster presentation]. MHSRS, Kissimmee, FL, USA.

Somberg, L., Shah, A., Yoganandan, N., Stemper, B., Baisden, J., Op 't Eynde, Bass, C., McMahon, J., Salzar, R., & McEntire, B. J. (2023). *Blunt cardiac contusion in live swine surrogate from behind armor blunt trauma* [Poster presentation]. MHSRS, Kissimmee, FL, USA.

Wolf, S., & Feltman, K. (2023). *Validity, reliability, and feasibility of electrocardiography indices as psychophysiological indicators of operator cognitive state* [Poster presentation]. MHSRS, Kissimmee, FL, USA.

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