DEPARTMENT OF DEFENSE RESEARCH PROJECTS

NEUROMUSCULAR RESEARCH LABORATORY UNIVERSITY OF PITTSBURGH

Department of Sports Medicine and Nutrition
School of Health and Rehabilitation Sciences
Department of Orthopaedic Surgery

"The effects of this early data have been immediate and profound as unit and medical leaders have an increased awareness of short falls in physical training and injury patterns. The protocols proposed for implementation in the next phase of the project will yield long term positive results that will enhance the medical readiness and combat effectiveness of all soldiers."

~ MG Jeffrey J. Schloesser, US Army Commanding General, 101st Airborne (Air Assault) Division, Fort Campbell, KY

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Department of Defense Injury Prevention and Performance Optimization Research

Awarded research grants totaling $5.3 million from the United States Department of Defense, the University of Pittsburgh's Neuromuscular Research Laboratory (NMRL) has been charged to study and develop models for injury prevention and performance optimization in soldiers of the Army 101st Airborne (Air Assault) at Fort Campbell, KY (Research grant USAMRMC/TATRC #W81XWH-06-2-0070/W81XWH-09-2-0095) and in Operators of Naval Special Warfare in Little Creek, VA (Research grant ONR #N00014-07-1-1190 #N00014-08-1-0412.)

The United States Department of Defense invests considerable resources in training to maintain the full operation of its elite soldiers. Unintentional, musculoskeletal injuries during tactical operation training and combat are a principal health concern within the military. Unintentional, musculoskeletal injury rates in military personnel parallel those of competitive athletes due to similar

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Human Performance Research Laboratories:

US Army 101st-For t Campbell, KY **Navy SEALs-Little Creek, VA**

Modeled after the Neuromuscular Research Laboratory (NMRL) and funded by the Department of Defense, separate research laboratories were constructed at Fort Campbell, KY and Little Creek, VA to conduct research that is designed to prevent injury and optimize performance.

Opened May 14, 2007, the laboratory at Fort Campbell, KY, consists of approximately 2500 sq/ft of testing space. Recently the facility that housed the **Human Performance Research Laboratory** has been converted to a full research center of excellence **(University of Pittsburgh Human Performance Research Center)** to include 10,000 sq/ft of research space for current testing activities, development and validation of the **Elite Tactical Athlete Training Program**, and education of Non-Commissioned Officers for training of the Division upon implementation of the evidenced-based program.

Similarly, a 2200 sq/ft human performance research laboratory was opened at Little Creek, VA to work directly with the Naval Special Warfare Group 2 Operators.

Both laboratories and the current NMRL are outfitted with instrumentation that is designed to measure upper extremity, lower extremity, and torso biomechanical performance during functional tasks, musculoskeletal strength, balance, flexibility, body composition, cardiorespiratory endurance, and anaerobic power.

Department of Defense Injury Prevention and Performance

"We're all excited about making better soldiers through science...our soldiers want to be better, stronger, faster, able to endure more…this helps them to do that"

~ Lt. Col. Rusty Rowe, Command Surgeon of Special Operations Command Europe and former Division Surgeon of the Army 101st Airborne

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training and physical demands placed on both the elite athlete and tactical athlete.

These projects are designed to provide a scientific approach to identify underlying risk factors to preventable musculoskeletal injuries, quantify physiological and metabolic demands of training, develop evidence-based injury prevention and performance optimization protocols, prospectively validate effectiveness to reduce injury, and in the long-term reduce injuries to enhance combat readiness. "We're finally putting the science behind that concept that every soldier is an athlete," said Lt. Col. Mark McGrail, Division Surgeon for the Army's 101st Airborne (Air Assault) Division.

Both projects will identify risk factors that are specific to either soldiers of the Army 101st or the Operators of Naval Special Warfare by correlating unintentional, musculoskeletal injury data with biomechanical, musculoskeletal, and physiological laboratory data. The laboratory tests are designed specifically for the soldiers of the Army 101st or the Operators of Naval Special Warfare and replicate the demands of their respective tactical operations. To date, 230 soldiers have been tested for the Army project and 70 for the Navy project. Current research activities for the Army also include the design and validation of an injury prevention model to be implemented at Fort Campbell. The intervention is part of the **Elite Tactical Athlete Training Program** and being conducted at the **University of Pittsburgh Human Performance Research Center**. Working collectively with the Human Performance Training team at Naval Special Warfare Group 2, a similar research process will evolve to validate current training methods to reduce injury and optimize performance.

Considering the high physical demands of tactical operations training and combat, and the fiscal implications associated with injury, implementation of injury prevention research is necessary to promote military readiness. The NMRL research initiative for the Army 101st and Navy SEALS will meet the collective desire of the Army Commanders and Naval Special Operations Forces Commanders to strategically maximize human capital, sharpen battlefield performance, extend the operational service life of the soldier and operator, and enhance wellness of the soldier and operator after service. "The SEAL operator himself is the primary weapons platform of Naval Special Warfare," said Captain Chaz Heron, commander of Naval Special Warfare Group TWO. "There is an imperative need to extend the operational life and maximize the battlefield performance of the operator." Development of a task and demand -analysis-based, empirically supported, and strategic injury prevention and human performance initiative will be the benchmark for all current and future components of the Army and Naval Special Warfare.

Reducing the risk factors associated with unintentional musculoskeletal injury will result in improved safety and performance of tasks within

the military as potentially injurious tasks are able to be performed more efficiently while prolonging the deleterious influence of fatigue. A reduction in injury will ultimately decrease the time lost due to disability, personnel attrition, and the financial burden associated with medical expenses and disability payments, and extending the operational life of the warfighter, while promoting military readiness of the tactical athlete.

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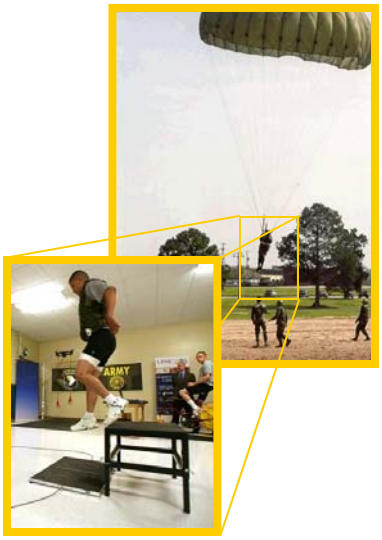
A Closer Look: The Technology Behind the Research

Located in each of the three laboratories is the technology necessary to carry out the biomechanical, musculoskeletal, and physiological tests behind the Injury Prevention and Performance Optimization Research

- High speed 3D infrared motion analysis system interfaced with force plates to perform kinematic and kinetic modeling using inverse dynamics during simulated tactical operation
- Electromagnetic tracking device to perform scapular kinematic modeling during overhead activities
- Surface electromyography (EMG) using an eight channel telemetric system to analyze muscle activation patterns necessary for joint stability during simulated tactical operation
- Isokinetic dynamometer to measure strength at various joints
- Electromagnetic cycle ergometer to perform anaerobic power testing
- Air Displacement Plethysmography to measure body composition
- Portable, telemetric metabolic system and portable lactate analyzer to measure cardiorespiratory fitness during field and maximal effort running



Tailoring Physical Training for Tactical Demands and Operation

Many of the demands Soldiers endure parallel those faced by the elite athlete; continued training, enduring fatigue, improving outcomes, all while remaining injury free and importantly attempting to balance everyday life. Significantly different underlying stressors that soldiers must face are live combat and pressures to remain battle ready. Literally speaking, the soldiers training must prepare them to perform optimally during physical threat from enemy. Preliminary data suggests that the specificity of the current traditional military physical training does not adequately prepare the soldiers for their physical challenges.

> *"You're not talking about shaving tenths of a second off a 40 time or winning a gold medal. ... the consequences of their physical conditioning are life and death, not wins and losses."*
>
> *~ Dr. Scott Lephart, Principal investigator, University of Pittsburgh*

"These soldiers are training like long distance runners with little emphasis on other energy systems," said Dr. Scott Lephart, the director of the project. "When they go into war they do not run for 10 miles. They're running in short bursts, crawling over obstacles — amenable to modern athletic training, football, basketball, soccer...things of that nature."

In addition, traditional physical exercises were performed uniformly across units without addressing the specific needs for each unique military unit.

"We know that an offensive lineman and a defensive back need different training, and that's the same approach we are taking with these soldiers," explained Dr. Lephart.

The **University of Pittsburgh Human Performance Research Center** (Fort Campbell, KY) has commenced clinical trial testing to empirically validate an 8-week physical training program tailored to meet the tactical demands and operation of the 101st. The evidenced-based **Elite Tactical Athlete Training Program** is geared toward enhancing those suboptimal biomechanical, neuromuscular, and physiological characteristics identified over 17 months of testing in Phase 1 of the project. The clinical trial will take approximately 4 months to complete. Once the tailored training program is validated, the program will be implemented for the arriving soldiers following redeployment. Current outlook of the US Army 101st Airborne regarding the Injury Prevention and Performance Optimization Project is well received and remains optimistic.

"We're all excited about making better soldiers through science," said former Division Surgeon Lt. Col. Rusty Rowe. "What we're trying to do is make training more realistic."

Key Points of the DOD Project

Objectives:

- To reduce the incidence of preventable, musculoskeletal injuries during command PT, recreation, training, and combat
- To enhance force readiness by maximizing training effects to reduce fatigue and optimize performance

Deliverables:

- Provide a scientific approach in order to:
  - Identify underlying risk factors to preventable injuries
  - Quantify physiological and metabolic demands of training
  - Develop evidence-based injury prevention performance optimization protocols
  - Study the nutritional considerations for performance and recovery to developed appropriate nutritional practices during training and forward deployment
  - Prospectively validate effectiveness to reduce injury

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The Neuromuscular Research Laboratory (NMRL) is the applied research facility of the University of Pittsburgh's Department of Sports Medicine and Nutrition within the School of Health and Rehabilitation Sciences. The NMRL collaborates with the Department of Orthopaedic Surgery and the University of Pittsburgh Medical Center as the primary clinical research division.

Since 1990, the NMRL has utilized a multidisciplinary research approach that facilitates the collaboration between orthopaedic surgeons, physical therapists, athletic trainers, epidemiologists, exercise physiologists, and bioengineers. The NMRL continues to focus on research in the area of proprioception and neuromuscular control, in an attempt to answer many of the clinical questions regarding the role of capsuloligamentous structures and the pathoetiology of joint injury. The objectives of our research are to study comprehensive profiles of an individual's function by evaluating both the sensory and motor characteristics specific to several clinical conditions. Biomechanical and neuromuscular assessments under sports-simulated environments are used to determine specific variables including investigating the influence of weight distribution, muscle function, balance, flexibility, muscle memory, gender, aging, and fatigue, as well as the effects of injury, surgery, and rehabilitation on joint stability. Deficiencies in body mechanics and muscle function are used to develop programs not only to improve performance but also minimize injury potential.