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Human Performance Optimization: An Evolving Charge to the Department of Defense

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Uniformed Services University of the Health Sciences hosted a conference in June 2006 entitled "Human Performance Optimization in the Department of Defense: Charting a Course for the Future" with the goal of developing a strategic plan for human performance optimization (HPO) within the Department of Defense (DoD). The conference identified key issues: (1) advocating for HPO at all DoD levels, (2) defining HPO specific to DoD requirements, (3) developing valid and standardized metrics for HPO, (4) translating HPO research into the operational community, and (5) establishing effective communication and coordination across military services and within the medical, research and operational communities. The program objectives should enhance mental and physical resilience of the war fighter; accelerate recovery; reduce injury and illness; provide seamless knowledge transfer from laboratory to line; improve the human system contribution to mission success; and allow the U.S. to remain in the lead in this area.

Introduction

The 21st century has brought unexpected challenges to the U.S. military and the Department of Defense (DoD). The Military Health System (MHS) has successfully responded to the new demands of the post-September 11 environment with an emphasis on a higher operational tempo through longer and more frequent deployments. The MHS has achieved unprecedented and dramatic results in combat casualty care: case fatality rates for combat injury during the Global War on Terror are roughly one-half that of Vietnam and one-third that of World War II.[1] Technological innovation has resulted in system changes such as the implementation of tactical combat casualty care at the point of injury, forward surgical team success with rapid forward resuscitative surgical intervention, and critical care air transport teams ensuring rapid exit of the critically wounded to higher levels of medical/surgical care.[1,2]

A new emphasis has been placed on the human as the most important weapon system in the Global War on Terrorism. The Global War on Terrorism, identified as "The Long War" in the 2006 Quadrennial Defense Review,[3] will demand optimal performance from Soldiers, Sailors, Airmen, and Marines. The Special Operations Forces has recognized that "humans are more important than hardware" in this new aspect of asymmetric warfare.

In May 2005, the Director of the Office of Net Assessment released a report entitled "Human Performance Optimization and Military Missions."[4] The report was based on interviews with four operational units along with discussions among medical and research personnel within the DoD in the area related to human performance. This report defined human performance optimization "as the relatively precise, controlled and combined application of certain substances and devices over the short and long-term to achieve optimization in a person or unit's performance overall."[4] This report resulted in a request from the DoD/Health Affairs (HA) to the Uniformed Services University of the Health Sciences (USUHS) to host a conference in June 2006. The goal of the conference was to initiate the development of a strategic plan for HPO within the military. This article summarizes the conclusions of the conference and the challenges facing the MHS in their efforts to optimize war fighter performance.

Methods/Approach

War fighters, line commanders, safety officers, health professionals, and researchers were among the 89 attendees from 56

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DoD organizations and the Coast Guard who participated in a workshop entitled "Human Performance Optimization in DoD: Charting a Course for the Future" held in June 7–9, 2006. The conference started with keynote remarks from DoD senior leadership concerning the importance of this effort. This was followed by presentations from the Air Force, Army, Navy, and U.S. Special Operations Command regarding research initiatives in HPO. The attendees were broken into five working groups to discuss current and brainstorm future approaches in HPO. The working group sessions consisted of the following: (1) dietary supplements and other self-improvement products, (2) leadership and teamwork, (3) physical training, (4) devices, and (5) innovative approaches. After several hours of discussion, presentations by each group were prepared to create a framework. The important HPO approaches identified on day 1 were applied to a war game scenario on day 2. The artificial scenario involved the rapid deployment of a unit to a fictitious land where the medical planner confronted human performance challenges including sleep deprivation, heat stress, altitude extremes, and prolonged nocturnal operations. The day 2 working groups were charged with applying HPO approaches to important aspects of predeployment, deployment/employment, and postdeployment. Day 1 working groups were reshuffled into new groups for the day 2 assignment to encourage more "outside the box" thinking.

In response to the success of the USUHS workshop, DoD/HA convened a HPO Integrated Product Team (IPT) to review the USUHS report, collect relevant data from the services, and initiate recommendations for a novel comprehensive HPO program. This effort resulted in a working definition of HPO and a directive to the Army Surgeon General to incorporate key HPO requirements, such as an information clearinghouse, into the Joint Medical Research Command as a key focus area.[5]

Findings

Based on the findings of the working group, issues were categorized as (1) organizational, (2) communication, (3) scientific, and (4) operational, based on the type of action required to resolve the identified obstacles to HPO within the DoD. Operational concerns were further subdivided into predeployment, deployment/employment, and postdeployment phases.

Organizational Issues

A definition of HPO within the DoD is viewed as a critical organizational issue, since this will allow the concept and application of HPO to be clearly embraced. A DoD definition of HPO will impart a vision and imply advocacy from above to guide war fighters, commanders, practitioners, and researchers. A HPO definition should be all-inclusive and not limited to the medical, MHS community, and culture. The definition must address target populations, embrace relationships with other areas and distinguish between disease treatment, "fitness" for health and wellness versus "fitness" to perform specific military tasks. The HPO definition must delineate the differences associated with HPO technology.

In the current environment, commanders have limited guidance concerning HPO, as some existing policies may be counterproductive. Existing policies need to be reviewed with guidance to ensure consistency of various HPO approaches. Importantly, a mechanism for its evolution in response to new developments must be identified. First and foremost, commanders want permission to enhance the performance of their war fighters. However, current guidance and policy may not endorse the concept of performance enhancement. As an example, the U.S. Special Operations Command has banned the use of all potential performance-enhancing products that are considered dietary supplements because of unknown, long-term side effects. Some products may be helpful for specific types of performance (e.g., creatine), and yet such products cannot be used because of existing policy. HPO advantages supported by science should be translated through consistent policies.

Another important organizational issue relates to operational translation of knowledge and research directly to commanders and war fighters. A Joint Center for Human Performance Optimization to focus on translating existing knowledge into the DoD standard of Doctrine, Organization, Training, Material, Leadership, Personnel, and Facilities would be a useful and critical step forward. However, the flow must be bidirectional such that the needs of the war fighter go directly back to the Center so requirements can be updated and new technologies pertinent to the battlefield can be identified.

Communication Issues

The dominant theme of the conference was communication. Commanders and clinicians in the field are typically unaware of current HPO information and research efforts. Operators at the highest levels are often unaware of laboratory research endeavors and existing solutions. To a great extent, important information about HPO is also unknown to the average war fighter; most of their information is derived from commercial venues trying to promote selected products. Likewise, it is not usual for researchers to access commanders to offer possible solutions or access lessons learned, which could and should direct research and development efforts. Operators and researchers need to be able to communicate directly with each other because effective communication strategies are requisite for HPO. Without effective mechanisms for facilitating communication among operators, medical personnel, and the various research communities, the war fighter may not have access to some important advantages. Cross-communication and synergy are requisites for addressing operational needs and acquiring new technologies in a timely manner.

Importantly, any form of communication must be joint and coordinated within and across services. The physiological and psychological principles are the same regardless of service, although the appropriate use and applications of HPO solutions will vary according to service and mission-specific requirements. Interactive and integrated communication would be optimal, such that consultative services, educational materials, and research efforts would all be linked. Finally, working scientists need opportunities to communicate with operators about developing projects. Organizations that conduct HPO research need to be teamed with representatives from acquisition, operators, and medical personnel from the field to discuss current research efforts, provide opportunities for cooperation, and direct future HPO needs.

Scientific Issues

The dominant scientific issues relate to the need for operationally relevant and standardized metrics to meet joint military requirements. Metrics are the single most important issue for research and application of HPO. Different metrics are in use by various laboratories and organizations and a few have been validated within narrow contexts. However, metrics that reflect combat effectiveness are limited. Importantly, few defined baseline metrics against which to measure the success of HPO approaches have been established. One example of a successful baseline metric is demonstrated within the DoD refractive surgery program: medical experts in coordination with line commanders and the aviation community defined baseline scientific visual metrics to monitor and improve performance in the operational environment. Once other relevant metrics are validated and standardized, baseline data can be collected for future comparisons. This effort will require significant coordination and several meetings of various communities to review and agree upon metrics that can be used both operationally and for military relevant HPO research.

In addition, unlike weapon systems where performance is monitored and life cycle is linear, the performance of humans is cyclical and time-phased (Fig. 1). The human "system" requires an integrated program of preparation, training, and monitoring before mission execution, followed by a sequenced period of recovery and "reset." This programming is carefully monitored for injury with rapid diagnosis and interventions for transitioning back into a preparatory phase for the next mission. HPO programming preserves human capital by addressing individual weaknesses and minimizing susceptibility to injury, disease, and other factors that influence performance.

Operational Issues

Collaboration between operators and medical researchers is essential for the development and operational fielding of effective HPO approaches. There is no substitute for the insights and experiences of war fighters in the field. With their help, critical areas within each of the three phases of operations were identified at the conference, with leadership, teamwork, and appropriate metrics always being emphasized.

Predeployment

The questions posed to the groups were "How do we and how should we prepare our war fighters for deployment? How can we minimize injuries during the preparation process?" The critical issues identified for the predeployment phase included functional fitness, performance nutrition, cognitive and psychological readiness, and preparation for prospective environmental threats. It was generally agreed that HPO approaches during predeployment strategies should have the greatest impact on minimizing problem areas for deployment and postdeployment phases. The approaches believed to be most effective for HPO during the training phases before deployment are presented in Table I in various categories.

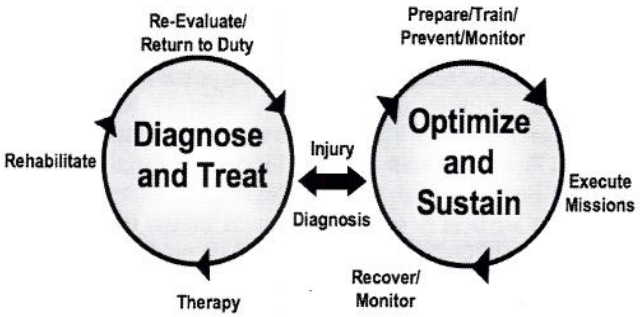

Fig. 1. Model for optimizing health and human performance.

Deployment/Employment

The question posed for HPO approaches during deployments was "How do we sustain predeployment preparation during deployments?" A number of the essential performance issues for the deployment phase were similar to predeployment, but additional ones, such as maintaining wakefulness, pain control, environmental exposures, cognitive overload, situational awareness, stress, communication/control, and language/cultural issues were identified. The issues proposed to be most responsive to HPO approaches during the deployment/employment phase are presented in Table II.

Postdeployment

Postdeployment, the last phase of operations, focused on deployment experiences and recovery. The crucial operational issues wherein HPO approaches would be helpful included return to functional fitness and predeployment physical state, psychological consequences associated with combat stress, exposures to diseases and toxins, and processes for reintegration. Specific areas of interest to HPO are included in Table III.

TABLE I

HPO APPROACHES FOR PREDEPLOYMENT HEALTH AND PERFORMANCE

Achieving and sustaining functional fitness	
Mission-based physical fitness program	Rest and recovery
Functional screen	Combat-specific metrics
Incentives for maintaining readiness	Biomarkers of physical fitness
Performance nutrition	
Predeployment diet plans	Nutrition education in training
Nutritional biomarkers for performance	Dietary supplements
Cognitive readiness	
Mental preparation and cognitive techniques	Memory aids and sleep plans
Biomarkers of cognitive readiness	Dietary supplements
Psychological readiness	
Desensitivity training	Cultural awareness
Stress inoculation	Relaxation techniques
Biomarkers for resilience	
Environmental threats	
Acclimation strategies	Nutrition and dietary supplements
Cognitive techniques	Personal protective devices
Biomarkers for susceptibility	

TABLE II

HPO APPROACHES FOR DEPLOYMENT/EMPLOYMENT HEALTH AND PERFORMANCE

Sleep, fatigue, and alertness	
Pharmacological agents	Various devices (light therapy)
Dietary supplements	Cognitive techniques
Pain and casualty care	
Dietary supplements	Devices (blood clotting, nanosecond pulsed electromagnetic field technology)
Performance nutrition	
Deployment diet plans	Dietary supplements
Situational awareness	
Cognitive techniques	Devices and human systems integration
Stress reduction	
Cognitive techniques	Mental self-management
Leadership and teamwork	Relaxation techniques
Environmental/occupational exposures	
Dietary supplements	Personal protective devices
Language/culture	
Hand-held language translators	Advanced educational devices

TABLE III

HPO APPROACHES FOR POSTDEPLOYMENT HEALTH AND PERFORMANCE

Regaining/return to functional fitness	
Rehabilitation programs	Rest and recovery
Functional rescreen	Acceleration of Healing
Biomarkers for "return to normal"	
Psychological consequences of combat stress	
Circadian resynchronization	Biomarkers of psychological state
Devices (light therapy)	Cognitive techniques
Subordinate evaluation of leadership	Relaxation/meditation
Reset programs	Family reintegration programs
Recovery nutrition	
Nutritional assessment	Dietary supplements
Environmental/occupational exposures	
Dietary supplements	Personal protective devices
Biomarkers of exposure	Devices for neutralization
Postdeployment processes	
Joint long-term follow-up strategies	Life cycle management of war fighters
Programs for reset and ramp-down	Maintaining unit integrity for war fighters
Long-term follow-up for reserve components	Technologies for facilitating reintegration
Targeted psychological assessments	Evaluation of postdeployment processes

Discussion

HPO depends on many factors, including biological, physical, psychological, cultural, and social, all of which interact. Management heuristics and nonpersonalized solutions have limited use and may actually compromise human performance. Thus, systematic approaches for optimizing human performance must be identified. From a systems perspective, performance optimization integrates four basic components: (1) a measurable function for selective maximization, (2) a set of variables which affect the objective function, (3) a set of constraints which allow the variables to assume certain characteristics, and (4) attention to the "ground" (function-cycle context) that addresses system priming and preparation and environmental optimization in which the variables operate. For HPO, we must identify these four basic components and determine how to maximize function by manipulating and shaping the constraints on the critical variables. Combat effectiveness and leadership are two overarching goals of the military. However, to optimize combat effectiveness, we must identify the specific functions and primary variables that impact human performance. The variables affecting function include biological attributes, cognitive abilities, training and motivational techniques, individual and social expectancies, leadership styles, and the use of products and devices and/or various types of equipment. The term HPO in this context reflects the application of various approaches and combinations of approaches that can optimize the performance of the war fighter to successfully achieve the mission.

Following submission of the USUHS HPO Conference Summary Report and a briefing to HA, an IPT was convened by HA to discuss and make further recommendations regarding HPO. The IPT reviewed, discussed, and validated the USUHS HPO conference findings, developed a working definition of HPO for use by HA (Office of the Secretary of Defense (HA)), and presented concrete recommendations to Office of the Secretary of Defense (HA). Importantly, the IPT, as suggested by the USUHS report, identified processes to facilitate HPO in conjunction with organizational options to implement the needed processes and functions. Furthermore, strong advocacy for HPO in the DoD was recommended. In part, this would be achieved by aligning HPO research to DoD priorities, facilitating interchange between researchers through chat rooms, a HPO library, and conferences, developing lines of communication between operational commands and HPO research to ensure synergy toward common endpoints, and by creating standards for HPO research. One primary avenue for integrating these multiple processes and functions would be through a DoD clearinghouse for HPO information. Although the previous clearinghouse (the Human Systems Information Analysis Center) failed to be sustained and supported through the services, a new effort is needed.

The recommendations of the IPT were reported and have resulted in an action memorandum. On January 4, 2007, the Assistant Secretary of Defense for HA signed a memorandum asking that HPO be established as a core program within the new Joint Medical Research Command.[5] The formation of a Joint Medical Research Command was previously announced in a memorandum signed by the Secretary of Defense on November 27, 2006.[6] The memorandum stated that a Unified Medical Research Command would be formed under the Army Medical Research and Materiel Command. A formal plan for this Joint Medical Research Command should be available in the spring of 2007. The majority of DoD medical research is already consolidated under the U.S. Army Medical Research and Materiel Command, and medical research on HPO is already coordinated through the Armed Services Biomedical

TABLE IV

KEY DoD LABORATORIES AND FUNDERS OF HPO RESEARCH

Laboratories (listed in decreasing order of annual core funding)
U.S. Army Research Institute of Environmental Medicine, Natick, Massachusetts
Department of Neuropsychiatry and Neurosciences, Walter Reed Army Institute of Research, Bethesda, Maryland
Naval Health Research Center, San Diego, California
Human Effectiveness Research Division, Air Force Research Laboratory, Wright-Patterson Air Force Base, Ohio
U.S. Army Aeromedical Research Laboratory, Fort Rucker, Alabama
Naval Submarine Medical Research Laboratory, Groton, Connecticut
Funding organizations
Defense Sciences Office, Defense Advanced Research Projects Agency, Arlington, VA
U.S. Army Medical Research and Materiel Command, Fort Detrick, MD
War Fighter Performance Department (code 34), Office of Naval Research, Arlington, VA
Air Force Office of Scientific Research, Arlington, VA
Army Research Office, Adelphi, MD
Biomedical Initiatives Steering Committee, Special Operations Command, Tampa, FL

Research Evaluation and Management Armed Services Biomedical Research Evaluation and Management, representing all service interests (Table IV). This can be readily enhanced and supported to expand the transition of HPO research to use across the DoD. As succinctly stated in a document put forth by the U. S. Special Operations Command: "Humans are more important than hardware."

Conclusions

Within the DoD, a focus on HPO is in development. A culture that emphasizes HPO is critical to the health and well-being and future effectiveness of our war fighters. The solutions exist for effective development and implementation of HPO in the DoD, and the people and organizations to conduct and implement those solutions are available. However, a structure to connect them is essential. Immediate attention is required to create an effective HPO program in the DoD. A robust HPO program will (1) enhance the mental and physical resilience of the war fighter; (2) Result in reduced injury and illness or more rapid recovery; (3) provide seamless information and knowledge transfer from laboratory to line; (4) improve the human weapons system's ability to accomplish the mission; and (5) allow the United States to remain at the leading/cutting edge in this area.

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