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ANNUAL HISTORICAL REPORT

CALENDAR YEAR 1991

U S ARMY RESEARCH INSTITUTE OF ENVIRONMENTAL MEDICINE

Natick, Massachusetts

UNITED STATES ARMY
MEDICAL RESEARCH & DEVELOPMENT COMMAND

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13. ABSTRACT (Maximum 200 words)

This report contains information concerning the mission, organization, key staff, overall funding and significant research accomplishments of the US Army Research Institute of Environmental Medicine, a subordinate element of the US Army Medical Research and Development Command, for calendar year 1991. Also included are listings of published reports, abstracts, presentations and key briefings for each Research Division of the Institute and significant accomplishments and appointments of the professional staff.

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ANNUAL HISTORICAL REPORT - AMEDD ACTIVITIES

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U.S. ARMY RESEARCH INSTITUTE OF ENVIRONMENTAL MEDICINE

NATICK, MASSACHUSETTS 01760-5007

CALENDAR YEAR 1991

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GENERAL INFORMATION

ORGANIZATION

The United States Army Research Institute of Environmental Medicine (USARIEM) is organized with an Office of the Commander, the Military Detachment, three Research Directorates, a Research Programs and Operations Division and an Administrative Support Division. The organization chart of USARIEM is attached as Appendix A.

The three Research Directorates were organized on 1 October 1990 to consolidate eight Research Divisions, as follows:

a. The Environmental Pathophysiology Directorate, Dr. Roger W. Hubbard, Director. The Directorate incorporates the Cellular Physiology and Pathology Division and the Comparative Physiology Division.

b. The Environmental Physiology and Medicine Directorate, Dr. Kent B. Pandolf, Director. The Directorate incorporates the Altitude Physiology and Medicine Division, the Biophysics and Biomedical Modeling Division, and the Thermal Physiology and Medicine Division.

c. The Occupational Health and Performance Directorate, Dr. James A. Vogel, Director. The Directorate incorporates the Military Nutrition Division, the Military Performance and Neuroscience Division, the Occupational Medicine Division, and the Occupational Physiology Division.

The Research Programs and Operations Division, Dr. Murray P. Hamlet, Director, incorporates the Research Plans and Operations Branch, the Bioengineering Branch and the Animal Care Branch.

The Administrative Support Division, Marc L. Eisenmann, Major, MS, Chief, incorporates the Resource Management Branch, the Information Management Branch and the Logistics Branch.

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LOCATION

USARIEM is located at the United States Army Natick Research, Development and Engineering Center (NRDEC), Natick, Massachusetts 01760-5000.

ACTIVATION AND ASSIGNMENT

a. By Section VI, General Order 33, Headquarters, Department of the Army, 20 September 1961, USARIEM was established as Class II activity under the jurisdiction of The Surgeon General, effective 1 July 1961.

b. General Order No. 40, Department of the Army, Office of the Surgeon General, 1 December 1961, assigned USARIEM to the United States Army Medical Research and Development Command, Washington, DC, effective 1 July 1961.

c. The USARIEM was last provisionally reorganized by Memorandum dated 25 September 1990, signed by the Deputy Commander of HQ, United States Army Medical Research and Development Command, effective 1 October 1990.

TENANCY

a. USARIEM is a tenant on the NRDEC installation and receives administrative and logistical support from NRDEC on a reimbursable basis and in accordance with an annually renewed intra-service support agreement.

b. The Pikes Peak Laboratory Facility, Colorado, is a subordinate activity of USARIEM and is utilized on a seasonal basis when a research requirement exists.

MISSION

To sustain and maximize the health and performance of individual military personnel, crews and troop populations through the conduct of basic and applied research programs in environmental medicine (heat, cold and altitude), and military work performance, training and nutrition. The Institute conducts basic research to elucidate mechanisms and sequelae of environmental stress and injury, and performs applied research to provide preventative and therapeutic countermeasures to the performance decrements, injuries and illnesses associated with military operations which expose forces to a wide spectrum of environmental conditions, physical and mental demands, materiel systems hazards and combat stress. Defines the complex interaction of environmental stress, operational stress and Army systems. Develops, evaluates and assists in the implementation of strategies to protect the soldier and enhance performance. In coordination with the U.S. Army Natick Research, Development and Engineering Center (USANRDEC) and through liaison with other Federal agencies, conducts research to develop the technology base required to evaluate feeding strategies for operational rations and nutritional supplements to minimize soldier performance decrements under sustained combat conditions. Discharges the Army Surgeon General's responsibilities as DoD executive agent for nutrition. Assists USANRDEC in the development of personal clothing and equipment by assessing the physiological impact of these items under all climatic conditions. Provides technical advice and consultant services to Army commanders, installations and activities in support of the Army Preventive Medicine Program and, on request, to other Federal agencies.

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PERSONNEL

STRENGTH AS OF: 31 December 1991

CIVILIANS	AUTHORIZED	ACTUAL
SES	1	1
GM	9	9
GS	74	75
WG	0	2

OFFICERS	AUTHORIZED	ACTUAL
MC	5	8
MS	12	13
VC	3	2
SP	2	3

ENLISTED	AUTHORIZED	ACTUAL
	54	55

TOTAL:	AUTHORIZED	ACTUAL
	160	168

KEY STAFF AS OF: 31 DECEMBER 1991

Gerald P. Krueger, COL, MS, Ph.D., Commander and Scientific/Technical Director

John F. Glenn, LTC, MS, Ph.D., Deputy Commander

Robert E. Burr, LTC, MC, M.D., Medical Advisor

Marc L. Eisenmann, MAJ, MS, Executive Officer and Director, Administrative Support Division

Monica L. O'Guinn, CPT, MS, Adjutant/Detachment Commander

Raymond W. Dickinson, SFC, Chief Medical NCO

James A. Vogel, Ph.D., Director, Occupational Health and Performance Directorate

John F. Patton, Ph.D., Chief, Occupational Physiology Division, Occupational Health and Performance Directorate

Bruce H. Jones, LTC, MC, M.D., Chief, Occupational Medicine Division, Occupational Health and Performance Directorate

Eldon W. Askew, COL, MS, Ph.D., Chief, Military Nutrition Division, Occupational Health and Performance Directorate

Richard F. Johnson, Ph.D., Acting Chief, Military Performance and Neuroscience Division, Occupational Health and Performance Directorate

Kent B. Pandolf, Ph.D., Director, Environmental Physiology and Medicine Directorate

Michael N. Sawka, Ph.D., Chief, Thermal Physiology and Medicine Division, Environmental Physiology and Medicine Directorate

Richard R. Gonzalez, Ph.D., Chief, Biophysics and Biomedical Modeling Division, Environmental Physiology and Medicine Directorate

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Allen Cymerman, Ph.D., Chief, Altitude Physiology and Medicine Division, Environmental Physiology and Medicine Directorate

Roger W. Hubbard, Ph.D., Director, Environmental Pathophysiology Directorate

Wilbert D. Bowers, Ph.D., Chief, Cellular Physiology and Pathology Division, Environmental Pathophysiology Directorate

Ralph P. Francesconi, Ph.D., Chief, Comparative Physiology Division, Environmental Pathophysiology Directorate

Murray P. Hamlet, D.V.M., Director, Research Programs and Operations Division

Andre A. Darrigrand, MAJ, VC, D.V.M., Chief, Animal Care Branch, Research Programs and Operations Division

John M. Foster, Chief, Bioengineering Branch, Research Programs and Operations Division

Richard L. Burse, Sc.D., Acquisition Management Liaison Officer, Plans and Operations Branch, Research Programs and Operations Division

Ms. Violet M. Trainer, Chief, Resource Management Branch, Administrative Support Division

Mr. Anthony J. Guerra, Chief, Information Management Branch, Administrative Support Division

Tim J. Jardine, CPT, MS, Chief, Logistic Branch, Administrative Support Division

Marie E. Stephens, Personnel/Manpower, Resource Management Branch, Administrative Support Division

ALLOCATION AND FUNDING

DA PROJECT NO.	TITLE	FUNDS
3M161101A91C	In-House Laboratory Independent Research	$ 59,000
3M161102BS15	Science Base of System Health Hazard Research	1,650,000
3M162787A875	Medical Chemical Defense - Exploratory Development	200,000
3M162787A878	Health Hazards of Military Materiel and Operations	705,000
3M162787A879	Medical Factors Enhancing Soldier Effectiveness	3,788,000
3M263002D819	Field Medical Protection and Human Performance Enhancement - Nonsystems Advanced Development	640,000
3M263002D995	Medical Chemical Defense Life Support Materiel - Nonsystems Advanced Development	504,000
3M463807D836	Combat Casualty Care Materiel - Advanced Development	30,000
3M463807D993	Medical Defense Against Chemical Threats - Advanced Development	320,000
TOTAL FY91 PROGRAM		$7,896,000

SUPPLY AND MAINTENANCE ACTIVITIES

During CY91, 4,795 requests were processed by the Logistics Branch as indicated below:

Non-expendable	810
Durable	251
Expendable	3,734

Additionally, the Logistics Branch turned in 528 items of excess equipment, processed four reports of survey, and submitted 75 work orders and 462 maintenance service orders.

The Medical Maintenance Section performed preventive maintenance on 2,263 items and sent 406 items to calibration.

BUILDING AND FACILITY EQUIPMENT

INSTRUMENTATION DESIGN AND DEVELOPMENT

The Bioengineering Branch contributed to the design and development of the following items for the period CY 91:

- Weaponeer Automation Device for computer control of Weaponeer target selection, target presentation intervals, and reaction time measurements (second of two units) was fabricated and is being tested.
- Epithelial Tissue Cooling/Rewarming Device to study the hypothermia effects of 96 tissue samples simultaneously. (Completed)
- Group Lifting Device to measure maximum strength of male or female lifting teams. (Completed)
- Litter Carry Support assembly for defining strength limitations of soldiers running on a treadmill. (Completed)
- Treadmill Safety Device for protection of human volunteers exercising on treadmills. (Last of four completed)
- Core Temperature Visual Warning Device for soldiers exercising in the field. (Completed)
- Breathing Tube Adapters for M-17 Gas Mask. (Completed)
- Water-cooled Cuvette Jacket for Miron Infrared Analyzer. (Initiated)
- Army Heat Stress Monitor (WBGT) developmental contract awarded. Drawings submitted for patent application.
- Joint ARIEM/MIT Nuclear Magnetic Resonance coil developmental device. (Initiated)

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- Peripheral Vision Testing Apparatus for detecting visual performance decrements at altitude. (Completed)

- Extracorporeal Electrochemical Electrode Sample Chamber and Fixation Device to analyze sodium and potassium ions. (Initiated)

- Linear positioner for a light projection system as part of a digital retinal photographic system. (Initiated)

BUILDING MODIFICATIONS

- Asbestos removed from penthouse equipment room, second floor, and basement hallways.

- Commenced installation of two modern environmental chambers and controls (Room 236).

- Completed Small Conference Room renovation.

- Submitted scope of work to New England Division, US Army Corps of Engineers, to extend loading dock.

- Contract awarded to have Immersion Pool Facility (Room 022) evaluated for electrical safety and lightning protection.

- Contract awarded through New York Division, US Army Corps of Engineers for design of replacement roof.

- Contract awarded to upgrade Immersion Pool control system.

- Contract completed for replacement of steam coils that temper air within animal colony.

- Contract awarded to install building security system.

OFFICE OF THE COMMANDER

SIGNIFICANT PROFESSIONAL ACTIVITIES:

1. The 78-page guide book for unit leaders and surgeons "Sustaining Health and Performance in the Desert-A Guide to Environmental Medicine for Operations in Southwest Asia", originally prepared by the Deputy Commander and the USARIEM staff in December 1990, was reformatted in January 1991 into a 5X7 inch pocket guide for small unit leaders and individual soldiers. An initial distribution of 6,800 copies was made at that time by air shipment (C-5) to all Army units deployed in SWA. Additional copies, to a total of 12,000, were widely distributed to Army units in USAEUR and CONUS not yet deployed, and to Navy, Marine, Air Force and Allied personnel.

2. Simultaneously with distribution of the Pocket Guide, the USARIEM Medical Advisor began preparation of a handbook for medical officers and military treatment facilities entitled, "Treatment of Heat Illness: A Handbook for Medical Officers." This handbook reached the field in SWA after termination of the combat phase, but was widely distributed to medical units in support of the clean-up/redeployment efforts.

3. Members of the USARIEM staff participated directly in both Operations Desert Shield and Desert Storm. MAJ Mary Mays and CPT Robert Moore, at the request of the 101st Air Assault Division's Aviation Brigade, deployed to Saudi Arabia prior to the ground campaign to provide on-site advice and consultation on issues of human health and performance during sustained operations under desert environmental and operational conditions. This team deployed into Iraq with the Brigade during Operation Desert Storm. LTC Bruce Jones performed extensive TDY providing preventive medicine training to all deploying CONUS medical units, while the professional staff at Natick provided similar training to more than one hundred medical personnel processing through Ft. Devens en route to SWA. USARIEM staff at Natick also responded rapidly to requests for information and advice throughout ODS, including support to Special Operations Forces on long-range patrol rations, to DCSLOG and NRDEC on nutritional adequacy of the Meals, Operational, Ready-to-Eat, (1500+ items evaluated), and

to many requests for guidance on proper use of chemical defense protective clothing and medical countermeasures, including a complete revision of the MOPP Analysis chapter of FM 3-4 at the request of the Chemical School. USARIEM also responded in rapid fashion to requests for health hazard assessments of a variety of materiel being deployed to SWA, including the new chemical casualty wrap, the pyridostigmine NAP, a topical chemical skin protectant, the new desert BDU and boot, and a variety of new chemical protective clothing items.

4. USARIEM served as the on-site host agency for the 26th meeting of the DoD Human Factors Engineering Technical Group at the Crowne Plaza Hotel, Natick, MA, 13-16 May 1991. The 166 tri-service members in attendance set a record for the highest participation ever. The attendees included internationally known scientists and researchers with expertise ranging across the wide spectrum of military human factors RDT&E.

5. The Surgeon General's professional short course, "Current Concepts in Environmental Medicine" was held at USARIEM 13-17 May 1991, with 49 physicians enrolled. Didactic units were presented in High Terrestrial Altitude, Cold and Heat, Physiology and Medicine; Military Health and Performance; Nutrition and Physical Standards; and Future Directions in Environmental Medicine. Institute lectures were given by Craig Llewellynn, M.D., Professor and Chairman, Department of Military Medicine, uniformed Services University of the Health Sciences (Medical Aspects of the Future Battlefield) and Charles Houston, M.D., Professor Emeritus, University of Vermont Medical School (Development of Altitude Medicine). A special presentation, "Lessons Learned from Operations Desert Shield/Storm" were made by two USARIEM staff members (MAJ Mary Z. Mays, Ph.D. and CPT Robert J. Moore, Ph.D.) based on their experiences while attached to the 101st Infantry Division (Air Assault) January-May 1991.

MANAGEMENT INITIATIVES:

1. The eighteen upper-level management personnel of USARIEM conducted an intensive organizational effectiveness and

management assessment retreat under the direction of Mr. Raymond J. Zugel, Management Consultant to OPM. The retreat was held off-site to eliminate distractions at Humarock, Scituate, MA, 22-24 October 1991.

2. A voluntary and confidential health risk appraisal program was initiated by the USARIEM Occupational Health Nurse to assist employees in identifying and overcoming any familial, lifestyle or medical history health risk factors.

MILITARY PERSONNEL ACCOMPLISHMENTS:

At the US Army Medical Research and Development Command "Soldier of the Year" competition for 1991, Staff Sergeant Donna R. Patterson of USARIEM's Cellular Physiology Division was named MRDC Non-Commissioned Officer of the Year and Specialist Linda P. Gowenlock of the Altitude Physiology and Medicine Division was first runner-up as MRDC Soldier of the Year. In addition, eight soldiers completed Air Assault School, including an honor graduate; two completed Airborne School; there were two outstanding PLDC graduates and one other on the Commandant's List, and a BNOC honor graduate.

PUBLICATIONS:

1. Burr, R.E. Review of Endocrinology of Thermal Trauma. The Endocrinologist 1:281-282, 1991.

2. Burr, R.E. Heat Illness: A Handbook for Medical Officers. USARIEM Technical Note 91-3, June 1991.

3. Glenn, J.F., R.E. Burr, R.W. Hubbard, M.Z. Mays, R.J. Moore, B.H. Jones, and G.P. Krueger (Eds.) Sustaining health and performance in the desert: Environmental medicine guidance for operations in Southwest Asia. USARIEM technical Note 91-2 (pocket version) Natick, MA: US Army Research Institute of Environmental Medicine, January 1991. (DTIC No. AD:A229-846).

4. Krueger, G.P. Environmental factors and military performance: An introduction. Pg. 211-213. In: R.Gal &

A.D. Manglesdorff (Eds.) Handbook of Military Psychology. Chichester, UK: Wiley & Sons, 1991.

5. Krueger, G.P. Sustained flight operations and pilot performance facts. Heliprops Human Ad (newsletter), 3:5-6. Fort Worth, TX: Bell Helicopter Textron, Inc., October 1991.

6. Krueger, G.P. Sustained Work, Fatigue, Sleep Loss and Performance: Review of the Issues. Proceedings of The International Conference on Human-Environment System, 395-398, December 1991.

7. Krueger, G.P. Environmental Medicine Research to Sustain Health and Performance during Military Deployment: Desert, Arctic, High Altitude Stressors. Proceedings of The International Conference on Human-Environment System, 583-586, December 1991.

PRESENTATIONS:

8. Burr, R.E. Osteoporosis. Clinical Staff Conference, Bassett Army Community Hospital, Fort Wainwright, Fairbanks, AK, February 1991.

9. Burr, R.E. Management of Diabetes Mellitus. Clinical Staff Conference, Cutler Army Community Hospital, Fort Devens, MA, April 1991.

10. Burr, R.E. Medical Research and Desert Operations; and Management of Work in Hot Environments. Shogun Medical Conference, Tokyo, Japan, April 1991.

11. Burr, R.E. Medical Aspects of Encapsulating Uniforms. Toxic Chemical Training Course for Medical Support Personnel, Savanna Army Depot, Savanna, IL, April, October 1991.

12. Burr, R.E. Introduction to Environmental Medicine. Current Concepts in Environmental Medicine Course, USARIEM, Natick, MA, 13-17 May 1991.

13. Glenn, J.F. Mission and Capabilities of the US Army Research Institute of Environmental Medicine. Presentation to

26th Annual DoD Human Factors Meeting, Natick, MA, 14, 15, 16, 17 May 1991.

14. Krueger, G.P. Fatigue, Mental Workload and Human Performance: Applications to Anesthesiologists and the Likelihood of Errors. Conference on Human Error in Anesthesia, sponsored by Anesthesia Patient Safety Foundation and US Food & Drug Administration, Pacific Grove, CA, 28 February 1991.

15. Krueger, G.P. Sustained Flight Operations and Pilot Performance. US Customs Bureau National Aviation Safety Conference, San Diego, CA, 1 March 1991.

16. Krueger, G.P. Sustaining Health and Performance in Operation Desert Shield & Desert Storm: An After Action Report of the US Army Research Institute of Environmental Medicine. US Army Medical R&D Command Commanders' Conference, Silver Spring, MD, 7 March 1991.

17. Krueger, G.P. Army Uniformed Research Psychologists: Making a Difference for Soldiers. Military Psychology Division 19, American Psychological Association Convention, San Francisco, CA, 19 August 1991.

18. Krueger, G.P. Sustained Work, Fatigue, Sleep Loss and Performance: Review of the Issues. International Conference on Human-Environment System, Tokyo, Japan, 5 December 1991.

19. Krueger, G.P. Environmental Medicine Research to Sustain health and Performance during Military Deployment: Desert, Arctic, High Altitude Stressors. International Conference on Human-Environment System, Tokyo, Japan, 7 December 1991.

20. Krueger, G.P. Seminars: Capabilities of US Army Research Institute of Environmental Medicine; and Sleep Loss, Fatigue and Sustained Performance. Department of Physiology, Kyoto Prefectural University of Medicine, Kyoto, Japan, 10 December 1991.

21. Krueger, G.P. Seminars: Capabilities of US Army Research Institute of Environmental Medicine; and Sleep Loss, Fatigue and Sustained Performance. Department of Physiology,

School of Medicine, University of Occupational and Environmental Health (UEOH), Yahatanishi-ku, Kitakyushu, Japan, 11 December 1991.

KEY BRIEFINGS:

22. Robert E. Burr, M.D., LTC, MC. USARIEM Medical Officer update to BG Ronald Blanck, M.D., Chief of Professional Services, OTSG, 24 October 1991.

23. Gerald P. Krueger, Ph.D., COL, MS, and staff. USARIEM capabilities, organizational update, and USARIEM's role of applied research in Soldier System programs, to Undersecretary of the Army for Research, Development and Acquisition meeting of the Army Science Board, Pentagon, Washington, DC 7 February 1991.

24. Gerald P. Krueger, Ph.D., COL, MS. USARIEM capabilities briefing to US Army Surgeon and staff Forces Command (FORSCOM), Ft. McPherson, GA, 8 February 1991.

25. Gerald P. Krueger, Ph.D., COL, MS. USARIEM capabilities briefing to Surgeon and staff, US Army Special Operations Command and US Army Central Command, MacDill, AFB, FL, 3 April 1991.

26. Gerald P. Krueger, Ph.D., COL, MS. USARIEM capabilities briefing and proposal to conduct nutritional evaluation of Ranger training program to Commandant and staff, US Army Ranger Training Brigade, Ft. Benning, GA, 4 April 1991.

27. Gerald P. Krueger, Ph.D., COL, MS. USARIEM capabilities briefing, and proposal to conduct applied research on AMEDD occupational, environmental and preventive medicine issues in collaboration or support of the Academy of Health Sciences (AHS), Ft. Sam Houston, TX, 4 June 1991.

28. Gerald P. Krueger, Ph.D., COL, MS. USARIEM capabilities briefing, and proposal to conduct applied physiological research, to Directorate of Combat Developments, US Army JFK Special Warfare Center, Ft. Bragg, NC, 24 July 1991.

29. Gerald P. Krueger, Ph.D., COL, MS. USARIEM capabilities briefing, and proposal to conduct applied research on altitude, cold, and nutrition issues of pertinence to the US Marine Corps and to US Army soldiers deployed to harsh environments, at US Marine Mountain Warfare Training Center, Bridgeport, CA, 20 August 1991.

SIGNIFICANT TDY:

Robert E. Burr, M.D., LTC, MC to participate in Cold Weather Ration Study, Ft. Greeley, AK, 22 January-9 February 1991.

Robert E. Burr, M.D., LTC, MC to participate in EPICON, Ft. Benning, GA, 24-27 March 1991.

Robert E. Burr, M.D., LTC, MC to attend Northern Operations Working Party, Essex Junction, VT, 20-22 May 1991.

Robert E. Burr, M.D., LTC, MC to participate in AMEDD Internal Medicine After-Action Review of ODS, Phoenix, AZ, 16-17 June 1991.

Robert E. Burr, M.D., LTC, MC to participate in USARIEM Heat Strain Study, Yuma PG, Yuma, AZ, 14-20 July 1991.

Robert E. Burr, M.D., LTC, MC to attend annual Preventive Medicine Officers Conference, Falls Church, VA, 23-25 September 1991.

Robert E. Burr, M.D., LTC, MC to participate in USARIEM Ranger School Study, Ft. Bliss, TX, 26-27 September 1991.

Gerald P. Krueger, Ph.D., COL, MS to participate in All-Army Technology Transfer Conference, Arlington, VA, 16-17 June 1991.

SIGNIFICANT VISITORS:

Army Audit Agency. Multi-site, continuing visit to investigate Army automation acquisition and internal control activities, January through March, 1991.

MG Richard T. Travis, Commander, USAMRDC and CSM Johnny M. Williamson, Command Sergeant Major, USAMRDC, 7-10 July and September, 1991.

BG Ronald Blanck, M.D., Chief Professional Services, OTSG. To discuss Army Medical Officer career program with USARIEM physicians and receive briefing from USARIEM Medical Advisor, 24 October 1991.

American Association for Laboratory Animal Care, tri-annual inspection visit, September 1991.

PROFESSIONAL APPOINTMENTS/ACTIVITIES:

Krueger, Gerald P., Ph.D., Commander. Chairman of the Board, Department of Defense Human Factors Engineering Technical Group 1991 meeting, Natick, MA; Chairman, Tri-service Symposium: Performance Implications of Military Operations in Chemical Protective Clothing, and invited presenter, Workload & Modeling Subgroup at the 25th Meeting of the DoD Human Factors Engineering Technical Group, San Diego, CA. Associate Editor, Military Psychology. Invited presentations, Conference on Human Error in Anesthesia, sponsored by Anesthesia Patient Safety Foundation and U.S. Food & Drug Administration, Pacific Grove, CA; and U.S. Customs National Aviation Safety Conference, San Diego, CA.

Burr, Robert E., M.D., Medical Advisor. Consultant in Environmental Medicine to Surgeon General, U.S. Army; Clinical Assistant Professor of Medicine, University of Illinois College of Medicine; and Group Leader, Endocrine Pathophysiology Course, Tufts University School of Medicine. Invited Faculty, 1991 Shogun Medical Conference, Tokyo, Japan, and Toxic Munitions Course for Health Care Personnel, Savanna Army Depot, IL. Elected fellow, American College of Emergency Physicians. Course Director, AMEDD Professional short course, "Current Concepts in Environmental Medicine." Reviewer, The Endocrinologist.

ENVIRONMENTAL PATHOPHYSIOLOGY DIRECTORATE

RESEARCH FINDINGS: EXECUTIVE SUMMARY

- Demonstrated that NPC 205, an adenosine antagonist, negatively affected treadmill endurance, thereby suggesting a role for adenosine in exercise performance in a rat model.

- Demonstrated that dichloroacetate enhanced pyruvate oxidation, resulting in decreased lactate accumulation which reduced muscle fatigue and increased endurance performance in an exercising rat model.

- Developed an animal model to study tissue blood flow and metabolism in individual organ beds during exposure to hot or cold environments.

- The atropine alkaloid in the atropine auto-injector was found to have almost identical thermoregulatory effects as atropine sulfate used in prior research when tested in the unrestrained rat model undergoing severe heat stress.

- Developed surgical techniques for implanting chronic non-occlusive catheters across organ beds in appropriate animal models.

- Determined that monitoring from vascular-access-ports may provide inconsistent measures of blood pressure.

- Concluded that thermal intolerance of potassium-deficient rats is probably unrelated to hydrational status.

- Demonstrated hypertonic saline in dextran (HSD) could be used to effectively treat rats for the shock-like syndrome of heat stroke.

- Demonstrated that freezing of artificial human skin containing only keratinocytes and fibroblast produces significant release of factors which could contribute to vascular phenomena such as leukocyte adhesion and vascular leakage.

SIGNIFICANT VISITORS:

Omar D. Hottenstein, Ph.D., Department of Physiology, School of Medicine, University of Colorado, Denver, Colorado, June 1991.

James Ross, D.V.M., Ph.D., Chairman, Department of Medicine, Tufts School of Veterinary Medicine, North Grafton, Massachusetts, June 1991.

LTC R. P. Solana, USAMRICD, Aberdeen Proving Grounds, MD., September 1991.

John S. Willis, Ph.D., Department of Zoology, University of Georgia, Athens, Georgia, September 1991.

SIGNIFICANT TDY:

Roger W. Hubbard, Ph.D. To attend Endotoxemia & Sepsis Conference, Philadelphia, PA, 5-7 May 1991. To attend First World Congress on Wilderness Medicine and to attend meeting of the Editorial Board, Journal of Wilderness Medicine, Whistler, B.C., Canada, 13-20 July 1991.

PROFESSIONAL APPOINTMENTS/ACTIVITIES:

Hubbard, Roger W., Ph.D., Research Director. Member, DOD Steering Committee on Field Water Quality. Adjunct Professor of Pathology, Boston University School of Medicine, Boston, MA. Member, Editorial Board, Journal of Wilderness Medicine Reviewer, Aviation Space and Environmental Medicine, Journal of Applied Physiology, and Journal of Wilderness Medicine. Invited by the American Physiological Society to co-author a chapter entitled "Limits of Tolerance to Heat" for the Handbook of Physiology. Invited by CRC Press to author a chapter entitled "Heat Illness Neurology" for a book on Tropical Medicine.

COMPARATIVE PHYSIOLOGY DIVISION

SIGNIFICANT RESEARCH FINDINGS/DEVELOPMENTS:

1. Dichloroacetate (DCA), a compound which enhances the rate of pyruvate metabolism thus reducing lactate formation, has been studied in a validated rat model of exercise/heat injury. Two groups of male rats (350g) were treated with either physiological saline (control, saline, IV) or DCA (5mg/kg) and were exercised to exhaustion in a chamber (26°C) on a treadmill (11m/min, 6° incline). When compared to controls, the DCA-treated rats had longer run times (169 vs 101 min.) and a decreased heating rate (.020 vs .029 °C/min.). In addition, DCA attenuated the normal exercise-induced increase in plasma lactate (28 vs 40 mg/dl) and reduced the depletion of leg muscle glycogen stores (1.6 vs 0.9 mg/g tissue) when compared to mean pre-exercise levels (4.2 mg/g tissue). These results suggest that the administration of DCA before exercise resulted in a decrease in lactate accumulation which, in turn, may reduce muscle fatigue and contribute to the increased endurance performance.

2. An A1 adenosine receptor blocker (NPC 205 (1,3-di-n-propyl-8-(4-hydroxyphenyl) xanthine) was studied to determine the effects of adenosine on exercise and thermoregulation in the heat. Two groups of adult male rats (350g) were treated with either saline (control) or NPC 205 (10mg/kg, i.p.) and were exercised to exhaustion at 30°C on a treadmill (11 m/min. 6° incline). The NPC group ran significantly less (41.4 vs 29.1 min.), exhausted at a lower core (41.4 vs 40.8 °C) and tail skin temperature (34.4 vs 33.2 °C) and manifested an increase in plasma lactate (6.4 vs 12.8 mmol/L) with concomitant acidosis (7.43 vs 7.28). This dosage of NPC may have also blocked the action of adenosine on tail-skin vasodilation and decreased blood flow to working muscle resulting in tissue hypoxia, lactic acidosis, and reduced endurance.

3. We earlier reported that rats which had been made potassium-deficient by consuming a potassium-free diet for 14d and were exposed passively to severe heat stress (T_{amb} = 41.5°C), manifested a significant decrease in thermal

tolerance. In those experiments the intensity of the heat exposure induced a rapid dehydration/hyperthermia (86 min - potassium-deficient, 178 min - control; T_{re} = 42.5 - 42.6°C, both groups). To extend our investigation into the effects of potassium depletion on thermoregulation/thermal tolerance, we maintained rats (n = 11 - 13/group) on a nutritionally complete (C), a potassium-deficient (-K), or a potassium-supplemented (+K) diet for 28 days, and determined the effects of passive exposure to a more moderate environment (T_{amb} = 31°C). At that environmental temperature the time required to reach the targeted level of hypohydration was similar in all groups (C = 18.1 h, 8.7% loss of body weight (BW), +K = 17.9 h, 8.1% BW, -K = 17.7 h, 8.1% BW). Final T_{re} ranged from 38.9°C (C) to 39.6°C (-K) when the targeted levels of hypohydration were achieved. During this more protracted period of dehydration, hematocrit, plasma protein, and osmolality were apparently unaffected by the dietary regimen. These data further support our initial hypothesis that the effects of potassium depletion on thermal tolerance may be related more to the metabolic heat production involved in electrolyte homeostasis than to the hydrational criteria. Tissues from these rats are being evaluated for sodium pump activity.

4. Non-occlusive catheters are rarely used in chronic animal preparations due to the difficulty and poor success of surgical implantation and long term maintenance. A technique for chronically implanting miniature non-occlusive catheters in small vessels without impeding blood flow, along with a probe to measure blood flow in these vessels, is required to study the response of individual organs when the body is stressed by environmental exposure. These devices must be functional for extended periods of time in order to assess the impact of environmental exposure on tissue blood flow, oxygen levels and damage, and then evaluate the efficacy of experimental treatments. We have instrumented and sampled from small vessels in the kidney, liver, inferior and superior mesentery, and skeletal muscle using devices and techniques developed in our laboratory. All catheters are constructed from silastic tubing, with internal lumen size varying from 0.012 to 0.020 inches for the venous and arterial catheters, respectively. Catheters are surgically implanted non-occlusively into the arteries and veins of these organ beds,

and exteriorized through the abdominal wall and routed subcutaneously to the back of the animal. The use of non-occlusive catheters will enable us to measure venous effluent from various organs in the conscious animal preparation.

5. Theories of environmentally-induced organ damage postulate that the redistribution of blood flow in response to the environmental insult may result first in tissue hypoxia and then damage, and that the degree and duration of hypoxia may determine the severity of damage. Measurement of arterial-venous differences for calculation of substrate delivery, extraction and metabolism at specific organs requires simultaneous sampling of arterial and venous blood, and measurement of blood flow to that tissue bed. We have surgically implanted non-occlusive catheters in the artery and vein, and a miniature flow probe about the artery of several organ beds typically affected by environmental injury. This project is unique in that, prior to initiating this work, only the kidney had been instrumented to measure blood flow and sample venous effluent in a chronic animal preparation. We have been successful in surgically implanting probes and non-occlusive catheters in the kidney, liver, skeletal muscle, and intestinal beds of 30 rabbits. Animals were allowed to recover, and then were evaluated recurrently and unrestrained for about one month. Organ blood flow, blood gases, oxygen content, and clinical chemistries have been measured. We have calculated delivery, extraction and utilization of oxygen by these tissues under control conditions, and we are currently prepared to examine the impact of various environmental stressors on blood flow, metabolism and tissue injury. These experiments should definitively determine whether tissue hypoxia plays a role in the extent of organ damage sustained following environmental insult.

6. Conventional methods for measuring blood pressure in animals include the use of silastic catheters inserted into a peripheral artery. Although the techniques for implanting, exteriorizing and maintaining patency of these silastic catheters are relatively straightforward, the ability of animals to access and sometimes destroy the exteriorized catheters is, in part, responsible for the loss of catheter function and termination of experiments. A vascular-access-port (VAP) consisting of a dome-shaped reservoir affixed to a

silastic catheter has replaced the conventional catheter in some studies. Because the reliability and validity of measuring blood pressure with the VAP are unknown, we compared blood pressures measured simultaneously with the two catheters. Preliminary data obtained using the anesthetized pig and rabbit show differences in the wave forms and pressures measured from the VAP and conventional catheter. The dicrotic notch present in the conventional silastic tracing, is usually absent from the VAP pressure tracing. Systolic pressure and hence, pulse pressure are generally lower with the VAP compared to the silastic catheter. Additionally, the magnitude of difference varies with the absolute pressure over the range of 30-300 mmHg. In addition to blood pressures, blood gas data obtained from both catheters will be compared in future experiments.

PUBLICATIONS:

1. Armstrong, L.E., P.C. Szlyk, I.V. Sils, J.P. De Luca, C. O'Brien, and R.W. Hubbard. Prediction of the exercise-heat tolerance of soldiers wearing protective overgarments. Aviat. Space Environ. Med. 62:673-677, July 1991.

2. Armstrong, L.E., R.W. Hubbard, E.W. Askew, J.P. De Luca, C. O'Brien, A. Pasqualicchio, and R.P. Francesconi. Responses to moderate and low sodium diets during exercise heat acclimation. Proc. Symp. Natl. Acad. Sci., Committee on Military Nutrition. (In Press), 1991.

3. Francesconi, R.P., R.W. Hubbard, N.M. Leva, R.C. Anderson, and L. Gowenlock. Potassium deficiency in rats: Effects on acute thermal tolerance. J. Therm. Biol. 16:No.2:77-82, Feb 1991.

4. Francesconi, R.P., L.E. Armstrong, N.M. Leva, R. Moore, P.C. Szlyk, W.T. Matthew, W.C. Curtis, Jr., R.W. Hubbard, ard E.W. Askew. Endocrinological responses to dietary salt restriction during heat acclimation. Nutrition for Work in Hot Environments. Proc. Symp. Natl. Acad. Sci. Committee on Military Nutrition. (In Press), 1991.

5. Szlyk, P.C., M.S. Rose, R.P. Francesconi, W. Matthew, D. Schilling, and R. Whang. Carbohydrate-electrolyte solutions during field training: An overview. Mil. Med. 156, 6:305-308, July 1991.

6. Szlyk, P.C., R.P. Francesconi, M.S. Rose, I.V. Sils, R.B. Mahnke, W.T. Matthew, R. Whang. Incidence of hypohydration when consuming carbohydrate-electrolyte solutions during field training. Mil. Med. 156, 8:399-402, August 1991.

7. Whang, R., W.T. Matthew, J. Christiansen, B. Brown, J. Smith, G. Thomas, M.S. Rose, P.C. Szlyk, L. Armstrong, and F.J. Schatzle. Field assessment of wet bulb globe temperature: Present and future. Mil. Med. 156:535-537, 1991.

ABSTRACTS:

8. Armstrong, L.E., R.W. Hubbard, J.P. De Luca, C. O'Brien, A.A. Pasqualicchio, G.J. Thomas. Effects of two dietary sodium chloride levels on exercise-heat acclimation responses. 1991 Annual Meeting of the American College of Sports Medicine, Orlando, FL, May-June 1991. Medicine and Science in Sports and Exercise. Vol. 23, Supplement, 1991.

9. Caretti, D.M., P.C. Szlyk, and I.V. Sils. Influence of training on ventilatory patterns and entrainment. The FASEB Journal. 5:A766, 1991.

10. Durkot, M.J., C. Bryda, R. Francesconi, and L. deGaravilla. The effects of a selective adenosine antagonist on cardiovascular, thermoregulatory and exercise performance. The FASEB Journal. 5:A765, 1991.

11. Francesconi, R.P., R.W. Hubbard, N.M. Leva, R.C. Anderson, and L. Gowenlock. Potassium deficiency: Effects on indices of heat/exercise injury and tissue electrolyte homeostasis. The FASEB Journal. 5:A768, 1991.

12. Szlyk, P.C., I.V. Sils, R.B. Mahnke, and L.E. Armstrong. Heat tolerance in prior exertional heatstroke patients. The FASEB Journal. 5:A1400, 1991.

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PRESENTATIONS:

13. Francesconi, R. Recurrent daily exercise in the heat: effects of a salt-restricted diet on hormonal responses. Committee on Military Nutrition, Washington, DC, April 1991.

SIGNIFICANT VISITORS:

Omar D. Hottenstein, Ph.D., Department of Physiology, School of Medicine, University of Colorado, Denver, Colorado, June 1991.

SIGNIFICANT TDY:

Ralph P. Francesconi, Ph.D. To attend Symposium of the Committee on Military Nutrition of the National Academy of Sciences/National Research Council, Washington, D.C., 10-12 April 1991. To conduct contract site visit at Texas College of Osteopathic Medicine and Jarvis Christian College. Ft. Worth, Texas, 10-12 September 1991.

PROFESSIONAL APPOINTMENTS/ACTIVITIES:

Francesconi, Ralph P., Ph.D., Division Chief. Proposal reviewer, Army Research Office. Advisor, NAS/NRC Research Associateship Program. Reviewer, Aviation Space & Environmental Medicine, American Journal of Physiology, Physiology and Behavior, Kidney International, and Journal of Applied Physiology. Invited by the American Physiological Society to author chapter entitled, "Endocrinological and Metabolic Response to Acute and Chronic Heat Exposure" for the Handbook of Physiology.

Durkot, Michael J., Ph.D., Research Physiologist. President, Natick Chapter of Sigma Xi, the Scientific Research Society (Jul 91-Jun 92). Reviewer, Aviation, Space & Environmental Medicine, Circulatory Shock, and Journal of Applied Physiology.

Gaffin, Steven L., Ph.D., Research Physiologist. Reviewer, Perspectives in Exercise Science and Sports Medicine, Volume 6; Invited by the American Physiological Society to co-author a chapter entitled "Limits of Tolerance to Heat" for the Handbook of Physiology; Official Reviewer, Conference on Perspectives in Exercise, Science, and Sports Medicine/Exercise, Heat, and Thermoregulation in Baveno, Italy, 18-21 June 1992.

Szlyk, Patricia C., Ph.D., Research Physiologist. Special Awards Judge, US Army Laboratory Command, International Science & Engineering Fair; National Finalist, Reserve Officer Association Junior Officer of the Year; selected Junior Officer of the Year by State of Massachusetts Reserve Officer Association; President, Natick Chapter of Sigma Xi, the Scientific Research Society (Jul 90-Jun 91); Executive Committee, Natick Chapter of Sigma Xi, (Jul 91-Jun 92); Reviewer, Aviation, Space & Environmental Medicine and Journal of Applied Physiology.

CELLULAR PHYSIOLOGY & PATHOLOGY DIVISION

SIGNIFICANT RESEARCH FINDINGS/DEVELOPMENTS:

1. Plasma fibronectin (PF) is a large molecular weight protein that facilitates reticuloendothelial system (RES) clearance of blood-borne particles such as tissue debris, fibrin clots and bacteria. Clearance of vascular debris resulting from tissue injury may explain, in part, the association of increased shock survival with elevated RES function. Stimulation of RES clearance in rats significantly reduces mortality induced by exposure to excessive heat. Moreover, heat shock mortality is reduced in rats that have a naturally elevated PF level. Active conditioning of soldiers significantly improves physiological adaptation factors (PAF), thermotolerance (TT) and PF level. PF's elevation with augmentation of both PAF and TT raised the question as to which of the latter two has the stronger correlation with PF.

Since passive conditioning, associated with seasonal change might elevate PAF, but not necessarily improve thermotolerance, it was of interest to determine the effect of such conditioning on PF level. Soldier PF level was unchanged by passive conditioning that improved PAF but not TT. This supported a stronger PF correlation with TT rather than with PAF. Unlike PAF, PF increases in healthy, fit soldiers undergoing conditioning might only be obtained when TT is improved. This suggests that conditioning-induced elevation of PF has potential as a marker for the presence of improved soldier TT.

2. Research on the thermoregulatory effects of atropine administration in the heat has been done primarily using atropine sulfate (AS). However, atropine auto-injectors contain atropine alkaloid (AA). This study was designed to quantitate any thermoregulatory differences of these 2 forms of atropine in the sedentary heat-stressed rat. Following drug administration via tail vein, sedentary rats (unrestrained) were subjected to heat stress (41.5°C) until a core temperature of 42.6°C was attained after which they were returned to a 26°C chamber and allowed to cool passively. Both the AS and AA groups had rates of rise of core temperature (mean $\pm$ SE) that were significantly ($p<.001$) higher than that of the control group (AS, 0.083 $\pm$ 0.003; AA, 0.083 $\pm$ 0.003; C, 0.020 $\pm$ 0.002 °C/min), and rates of water loss that were significantly ($p<0.005$) lower than that of the control group (AS, 0.11 $\pm$ 0.02; AA, 0.12 $\pm$ 0.01; C, 0.17 $\pm$ 0.01 g/min). Administration of either AS or AA results in the same thermoregulatory decrements in the sedentary heat-stressed rat.

3. Hyperthermia may be accompanied by dehydration either with electrolyte loss (sweat loss in man or saliva spread in rats for evaporative cooling) or without it (water deprivation). To determine the efficacy of hypertonic saline in dextran solution (HSD, 7.5% NaCl in 6% dextran 70) in the treatment of heat stroke, rats were first deprived of water for 24 hr or not, then heat-stressed while either restrained to prevent saliva spread or unrestrained, and finally administered 4 ml/kg of saline (SAL) or HSD via tail vein at the end of heat stress (a core temperature of 42.3°C). Rats that were water deprived had significantly ($p<0.05$) higher

heating rates and less water loss during heating than non-deprived rats, but hydration status was not correlated to 24 hr survival with a 42.3°C endpoint. Rats that were restrained had significantly less weight loss, less thermal area, and higher cooling rates than unrestrained rats; but, there was no significant difference in 24 hr survival between the two groups. HSD groups had significantly higher survival rates than their corresponding SAL groups. Therefore, in heat-stressed rats, HSD administration is more beneficial for the treatment of heat stroke than SAL, regardless of hydrational status.

4. Microvascular integrity and the presence of substances in blister fluid, such as prostaglandins, have been implicated in the severity of frostbite. To separate vascular effects of frostbite from those produced by focal injury to other skin cells, artificial human skin, or "LSE", (Organogenesis, Cambridge, MA), was used to evaluate nonvascular aspects of freeze-thaw injury to skin. Initial studies indicated that release of IL-1α increased 24 hr after freezing and rewarming, while prostaglandin (PGE_2) release decreased. However, K^+ leakage was elevated in 24-hr control samples indicating, as suggested by the supplier, that the shipping media should be completely removed prior to use. For this reason, 12 pairs of chambers containing LSE were removed from carrier trays, washed twice (30 min. at 37°C) and placed in assay wells. One chamber of each pair was maintained at room temperature, while the other was cooled at 1°C/min. to -15°C and then rewarmed to 20°C. Both chambers were then incubated for 24 hr in fresh media. IL-1α, PGE_2 (RIA) and K^+ (atomic absorption) leakage were measured for both groups after the frozen group was rewarmed, and also after 24 hr at 37°C in fresh media. After frozen samples were rewarmed, control values (mean $\pm$ SE) for PGE_2 (222 $\pm$ 46pg/ml), IL-1α (57 $\pm$ 10pg/ml) and K^+ (4.32 $\pm$ 0.02 mM) were significantly different from their respective frozen/rewarmed values (1640 $\pm$ 232, 243 $\pm$ 22, and 6.47 $\pm$ 0.41). After 24 hr incubation at 37°C, frozen/rewarmed values (PGE_2=11,260 $\pm$ 2,080; IL-1α=860 $\pm$ 68) were dramatically increased compared to control values (2,290 $\pm$ 50, 49 $\pm$ 7), except for K^+ which had returned to the normal range (frozen/rewarmed=4.39 $\pm$ .03; control=4.65 $\pm$ .02). Ultrastructural evaluation indicated significant damage to keratinocytes 24 hr after freezing and rewarming. These

results indicate that freezing causes significant damage to nonvascular skin cells, releasing PGE_2, IL-1α and K^+ from the cell types present in LSE. These may affect the outcome of frostbite, and contribute to other vascular phenomena, such as leukocyte adhesion and vessel leakage.

PUBLICATIONS:

1. Daum, P.S., W.D. Bowers, Jr., J. Tejada, D. Morehouse, and M.P. Hamlet. Cooling to heat of fusion (HOF), followed by rapid rewarming, does not reduce the integrity of microvascular corrosion casts. Cryobiology 28:294-301, 1991.

2. Matthew, C.B. Anticholinergics: Effects on thermoregulation and performance in rats. Neurosci. & Biobehav. Reviews. 15:141-146, 1991.

3. Matthew, C.B. Thermoregulatory effects of atropine sulfate and atropine alkaloid in the heat-stressed rat. Proc. Med. Def. Biosci. Rev. 591, 1991.

ABSTRACTS:

4. DuBose, D.A. Effects of seasonal change on basal and exercise levels of plasma fibronectin (PF). FASEB J. 5:A767, 1991.

5. Matthew, C.B. Ambient temperature effects of physostigmine in exercising rats. FASEB J. 5:A1401, 1991.

PRESENTATIONS:

6. Matthew, C.B. Thermoregulatory effects of atropine sulfate and atropine alkaloid in the heat-stressed rat. 1991 Med. Def. Biosci. Rev., Aberdeen Proving Ground, MD. August 1991.

KEY BRIEFINGS:

Bowers, W.D. Division Directors' Presentations to USAMRDC Fellows, USARIEM, Natick, MA. 15 February 1991.

PROFESSIONAL APPOINTMENTS/ACTIVITIES:

Bowers, Wilbert D., Ph.D., Division Chief. Treasurer, New England Society for Electron Microscopy.

Matthew, Candace B., MAT, Research Biologist. Reviewer, Aviation, Space and Environmental Medicine, and Life Sciences.

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ENVIRONMENTAL PHYSIOLOGY & MEDICINE DIRECTORATE

RESEARCH FINDINGS: EXECUTIVE SUMMARY

- Determined that physical exercise did not alter the onset, incidence or severity of acute mountain sickness.
- During acclimatization to high altitude, lactate disposal was found to increase coupled with a decreased contribution of carbohydrates to fuel metabolism.
- Physical exercise and acute altitude exposure were found to have similar, but independent, detrimental effects on rifle marksmanship.
- During short-term exposure to high altitude, changes in intraocular pressure were shown to represent a potentially unique, non-invasive method of monitoring altitude-induced changes in cerebral circulation.
- During a field exercise in Bolivia at high altitude, the use of the Gamow Bag, which is a portable hyperbaric chamber, was found to be an effective treatment modality for high altitude pulmonary edema.
- Determined that 0.25 mg of triazolam (Halcion) was efficacious in the treatment of insomnia resulting from acute exposure to high altitude (4000 m).
- Determined sensor requirements and provided software for prototype Army environmental heat stress/strain monitor.
- Obtained high temporal frequency and spatial frequency environmental data in parallel with human performance data to support predictive model validation and enhancement.
- Significant input was contributed to U.S. Army FM 3-4 by the development of computer generated graphical tables displaying tolerance times as a function of the WBGT modified by work intensity in various MOPP configurations.

- As part of the P^2NBC^2 program, an Ada version of the USARIEM Heat Strain Model was developed and found to be useful in integrating Tactical Decision Aid systems.

- In a P^2NBC^2 sponsored field study at Ft. Bliss, TX, maximum endurance time was found to be 204 min for a daylight test in MOPP-4 at a moderate work.

- Developed a conservative model to predict endurance times for thermally insulated, cold-stressed digits.

- Determined that dehydration reduced the core temperature that could be tolerated during exercise-heat stress.

- Determined that aerobic fitness, per se, did not influence the magnitude of physiological heat strain that could be tolerated.

- Predictive curves were developed to estimate exhaustion rates for a given level of physiological strain during exercise-heat stress.

- The efficacy of endurance training programs for improving aerobic capacity was found to be similar, whether the exercise programs were performed in cold or warm environmental conditions.

- Multiple low doses of pyridostigmine bromide subtly lowered resting heart rate and core temperature in a hot environment, and lowered resting heart rate in a warm environment.

PUBLICATIONS:

1. Pandolf, K.B. Aging and heat tolerance at rest or during work. Exp. Aging Res. 17: 189-204, 1991.

2. Pandolf, K.B. and A.J. Young. Environmental Extremes and Performance. In: Sports and Human Endurance. P.O. Astrand and R.J. Shepherd (Eds.). Blackwell Scientific Publications, Ltd., Oxford. (In Press), 1991.

3. Pandolf, K.B. Importance of Environmental Factors for Exercise Testing and Exercise Prescription. In: Exercise Testing and Exercise Prescription for Special Cases-Theoretical Basis and Clinical Application. 2nd Edition, J.S. Skinner (Ed.). Lea & Febiger, Philadelphia, Pennsylvania, (In Press), 1991.

4. Pandolf, K.B. and A.J. Young. Altitude and Cold; The Cardiac Patient. In: Heart Disease and Rehabilitation. 3rd Edition, M.L. Pollock and D.H. Schmidt (Eds.). Human Kinetics Publishers, Inc., Champaign, Illinois, (In Press), 1991.

5. Pandolf, K.B. Heat tolerance and aging. Exp. Aging Res. (In Press), 1991.

6. Pandolf, K.B., R.W. Gange, W.A. Latzka, I.H. Blank, K.K. Kraning and R.R. Gonzalez. Human thermoregulatory responses during heat exposure after artificially-induced sunburn. Am. J. Physiol. (In Press), 1991.

7. Pandolf, K.B., R.W. Gange, W.A. Latzka, I.H. Blank, A.J. Young and M.N. Sawka. Human thermoregulatory responses during cold-water immersion after artificially-induced sunburn. Am. J. Physiol. (In Press), 1991.

ABSTRACTS:

8. Pandolf, K.B., R.W. Gange, W.A. Latzka, I.H. Blank, A.J. Young and M.N. Sawka. Human thermoregulatory responses during cold-water immersion after artificially-induced sunburn. FASEB J. 5:A393, 1991.

9. Pandolf, K.B. Can you enhance capacity for performance in the heat? Proceedings of The First World Congress on Wilderness Medicine, Whistler, British Columbia, Canada, 1991.

10. Pandolf, K.B. Heat tolerance and aging. Proceedings of Second Annual International Stein Conference, Philadelphia, Pennsylvania, 1991.

PRESENTATIONS:

11. Pandolf, K.B. Environmental Physical Stress: High Altitude, Cold and Heat. Lecture at the U.S. Army War College, Carlisle Barracks, Pennsylvania, March 1991.

12. Pandolf, K.B. Sustaining Soldier Physiological Performance in the Desert. Lecture at Sargent College of Allied Health Professions, Boston University, Boston, Massachusetts, April 1991.

13. Pandolf, K.B. Sustaining Human Performance in the Desert. Lecture at Boston-Bouve College of Human Development Professions, Northeastern University, Boston, Massachusetts, May 1991.

14. Pandolf, K.B. Wilderness Medicine Applications from the U.S. Army Research Institute of Environmental Medicine. The First World Congress on Wilderness Medicine, Whistler, British Columbia, Canada, July 1991.

15. Pandolf, K.B. Influence of Heat Stress on Human Performance During Exercise. Biology Tutorial, Biology Department, Harvard University, Cambridge, Massachusetts, October 1991.

16. Pandolf, K.B. Research Principles and Axioms. Presentation delivered at Symposium before the New England Regional Chapter of the American College of Sports Medicine, Marlborough, Massachusetts, November 1991.

17. Pandolf, K.B. Temperature Regulation and Human Performance in the Heat. Lecture at Sargent College of Allied Health Professions, Boston University, Boston, Massachusetts, November 1991.

KEY BRIEFING:

18. Kent B. Pandolf, Ph.D. Health Hazard Assessment; U.S. Army Medical Research and Development Command, Fort Detrick, Frederick, MD, November 1991.

SIGNIFICANT VISITORS:

Dr. Donald E. Holness, Canadian Defence Liaison Staff, Washington, D.C.

Dr. J. Richard Allan, Army Personnel Research Establishment, Ministry of Defence, Farnborough, United Kingdom.

Dr. Peter Tikuisis, Defence and Civil Institute of Environmental Medicine, North York, Ontario, Canada.

Dr. Enzo Cafarelli, Department of Physical Education and the Graduate Program in Exercise and Sport Science, York University, Toronto, Canada.

PROFESSIONAL APPOINTMENTS/ACTIVITIES:

Pandolf, Kent B., Ph.D., Research Director. Adjunct Professor of Health Sciences, Department of Health Sciences, Sargent College of Allied Health Professions, Boston University, Boston, MA; Adjunct Clinical Professor of Sports Biology, Springfield College, Springfield, MA; Advisor, NAS/NRC Research Associateship Program. Vice-President and Board of Directors, International Society for Adaptive Medicine, Freiburg, FRG. Chairman, Publications Committee, American College of Sports Medicine; Chairman, Publications Task Force, American College of Sports Medicine. Counselor, Steering Committee, Environmental and Exercise Physiology Section, The American Physiological Society. Editorial Board Member, Ergonomics, and Exercise and Sport Sciences Reviews. Guest Book Reviewer: Sports Medicine Bulletin. Reviewer, Medicine and Science in Sports and Exercise, Journal of Applied Physiology, Perceptual and Motor Skills, Journal of Cardiac Rehabilitation, European Journal of Applied Physiology and Occupational Physiology, and Aviation, Space and Environmental Medicine.

ALTITUDE PHYSIOLOGY & MEDICINE DIVISION

SIGNIFICANT RESEARCH FINDINGS/DEVELOPMENTS:

1. Individuals have widely differing susceptibilities to acute mountain sickness (AMS). It is unknown whether increased activity affects the onset, incidence and severity of AMS. Sixteen male soldiers resided for 36 hours at 4600 m simulated altitude on two occasions. During one exposure, the men exercised a total of 10 hours at 50-75% of their maximal oxygen consumption. During the other exposure, the men remained sedentary. Exercise did not alter the rate onset and caused little change in susceptibility to and severity of AMS during acute exposure to high altitude.

2. A special ergometer has been developed for measuring muscle fatigue during dynamic exercise, with a number of applications. During muscle contractions (both submaximal and maximal) of the quadriceps muscle, a number of metabolic and respiratory measurements, as well as electromyography and electrical stimulation, will be performed in normoxia and hypoxia during exercise. A variety of interventions will also be utilized to determine their effects on local muscle function. These will include: blood flow occlusion, induced alkalosis, caffeine, the addition of larger muscle groups, long-term altitude exposure and nicotinic acid.

3. The effects of hypoxia on lactate metabolism were studied in six adult males (age 28±2 (X±SE) year, 79.5±5.4 kg) at sea level (SL) and after 13 to 14 days at high altitude (3700-4300 m) (HA). A constant infusion of ^{13}C lactate was used to measure the rate of apparent lactate turnover (Rlac) at rest and during 1 h of steady-state treadmill exercise at 70% of the environment-specific $\dot{V}O_2max$. AT SL, Rlac significantly increased 2.7-fold from rest to exercise (117±24 to 318±58 $\mu mol \cdot kg^{-1} \cdot min^{-1}$), while at HA, Rlac increased 2.0-fold (298±66 to 595±142 $\mu mol \cdot kg^{-1} \cdot min^{-1}$). Resting Rlac increased 2.5-fold while exercise Rlac increased 1.9-fold from SL to HA. Exercise respiratory exchange ratio (VCO2/VO2) decreased from SL (0.95±.01) to HA (0.91±0.01). These data indicate an

increased capacity for lactate disposal coupled with a decreased contribution of carbohydrates to fuel metabolism with acclimatization to HA.

4. Acclimatization to high altitude decreases the fractional contribution of blood glucose to fuel metabolized during prolonged exercise at high altitude. Six normal adult male soldiers (27±2 yr, SEM) were studied at sea level and after 13 to 14 days at high altitude (3700 to 4300 m). The rate of lipolysis, i.e., the rate of glycerol release into the blood (Ra glycerol), and glucose appearance (Ra glucose), were measured during 4 hours of uninterrupted treadmill exercise at 51%±1 (mean±SE) of the environment-specific $\dot{V}O_2$max. The Ra glycerol and Ra glucose were quantified by a primed, constant infusion of D-5 glycerol and 6,6-D2 glucose, respectively. Both Ra glycerol and Ra glucose increased markedly during the 4 h of exercise. While total glycerol release was unchanged (283.5±14.5 mM at sea level vs. 237.2±30.8 mM at altitude) total glucose concentration during exercise was greater at sea level (435.6±29.4 mM) than at high altitude (375.7±18.3 mM). These data indicate a decrease in the fractional contribution of blood glucose to fuel metabolized during prolonged exercise at high altitude.

5. Availability of liquid carbohydrate supplement significantly increased voluntary carbohydrate intake by soldiers during a winter field training exercise at moderate altitude. Although approximately 400 g/CHO/day are needed to maintain muscle glycogen stores in active individuals, soldiers frequently do not consume enough rations to meet these requirements during strenuous field training exercises (FTX). In order to quantify the voluntary consumption of a liquid CHO supplement (1200 kcal/day, 300 g/CHO/day) and to a pre-packed field ration (4000 kcal/day, 400 g/CHO day), 10 male soldiers (age 32±5 yrs, ht 180±7 cm, wt 81.2±9.7 kg, X±SD) participated in a 6 day FTX at 2100 to 3100 m elevation. Energy expenditure (intake/balance) and food intake (logbook records) were determined. Energy expenditure was 4392±1243 kcal/day. The soldiers consumed 2053±265 kcal/day with 229±55 g/CHO day from the field ration. With the CHO supplement added, soldiers consumed 2467±384 kcal/day with 332±35 g/CHO/day. Subjects consumed only 58% of their estimated energy needs. Addition of the CHO beverage supplement

increased total CHO intake by 31% (103 g/CHO/day). Liquid CHO supplementation made a significant contribution to CHO intake during this physically demanding FTX.

6. The separate and combined effects of exercise and high altitude (3700 m to 4300 m) on marksmanship accuracy and sighting time were quantified in sixteen experienced marksmen. Subjects dry-fired a disabled M16 rifle equipped with a laser-based system from a free-standing position. The 2.3 cm circular target was at a distance of 5 m. Marksmanship was assessed: (1) at rest at sea level, (2) immediately after a 21 km run/walk ascent from 1800 m to 4300 m altitude (3) at rest during days 1-3 at altitude, (4) at rest during days 14-16 at altitude, and (5) immediately after a second ascent after 17 days at altitude. Exercise significantly reduced marksmanship accuracy. However, after residence at altitude, accuracy and sighting time at rest returned to sea level values. It was concluded that exercise and acute altitude exposure had similar but independent detrimental effects on marksmanship.

7. Significant decrements in visual function have been shown during short-term exposure to high altitude. Intraocular pressure (IOP), visual fields, acuity, vergence, phoria and visual evoked response (VER) were measured in 11 healthy males at sea level and after 2, 4, 6, 17, 19 and 21 days at 4300 m. IOP decreased significantly from 14.5±2.4 mmHg (X±SE) at sea level to 12.0±2.3 mmHg after 4 days exposure to altitude and remained at that level on days 6, 17, 19 and 21. IOP also decreased significantly immediately after maximal aerobic cycle exercise performed at sea level (14.5±2.4 mmHg to 11.4±2.0 mmHg) and on days 4 and 19 at altitude (13.0±2.4 mmHg to 9.0±2.4 mmHg). Retinocortical function as measured by VER was unchanged at 4300 M. There was no change in the measurement of visual fields, acuity, vergence, and phoria during altitude exposure compared to sea level. Changes in IOP may result from alterations in retinal circulation and may represent a unique, noninvasive way of monitoring altitude-induced changes in cerebral circulation.

8. It is well known that short-latency evoked potentials (ERPs) are altered by severe hypoxia. However, it is unclear how long-latency ERPs are affected. Since previous studies have shown that affected by mild hypobaric hypoxia, a study

was performed to determine whether ERP measures of these capacities also would be altered by hypobaric hypoxia. Brain electrical activity (Fz, Cz, Pz) and ear oximetry (percent Sa^{O2}) were recorded in eight male subjects during an auditory paradigm at 0900, 1600 and 1800 hours (baseline). On Day 2 at 0745 hr, the testing chamber was decompressed to a simulated altitude of 14,104 ft (448 torr). ERPs and ear oximetry were again recorded at 0900, 1600 and 1800 hours (altitude). Amplitude of P300 was attenuated at altitude compared to baseline for the 1600 and 1800 hr test sessions but not at the 0900 hr session. Percent Sa^{O2} also decreased from BASELINE to ALTITUDE. Counting accuracies remained consistently high across days. The results indicate that P300 amplitude is sensitive to hypobaric hypoxia, and is consistent with previous reports of performance decrements in memory and decision making. That P300 amplitude rather than latency was affected and suggests that decrements during mild hypobaric hypoxia exposure may be related more to motivational (psychological) than to physiological factors. The failure to note amplitude differences between days at 0900 hr suggests that only hypobaric exposures greater than two hours produce ERP decrements.

9. Fourteen soldiers experienced high altitude pulmonary edema (HAPE) from a task force of 309 U.S. Army personnel who arrived at high altitude in Bolivia from Fort Riley, Kansas. The task force lived and worked at 12,000 to 13,000 feet terrestrial elevations while participating in Exercise Fuertes Caminos Bolivia. The incidence of HAPE depends upon the altitude achieved, ascent rate and physical activity level. The 4.5% HAPE incidence in this Army population was significantly greater than the 0.5% incidence previously reported after ascent to 12,000-14,000 feet. Immediate descent for the HAPE casualties was not practical. Treatment of HAPE varied per individual and included the use of oxygen, diuretics, positive pressure ventilation, and a portable hyperbaric chamber (Gamow bag). The Gamow bag was used to treat five patients who did not respond to oxygen therapy. Pressurization with the foot pump at the Bolivian base camp resulted in a simulated descent of approximately 5000 feet inside the bag. Four of the five patients treated in the Gamow bag exhibited complete resolution of symptoms within 20 minutes of initial hyperbaric treatment. Two of the four

patients initially responding to hyperbaric therapy subsequently relapsed into HAPE and required evacuation. The successful use of the Gamow bag in treating HAPE resulted in the rapid return-to-duty of soldiers who would otherwise have required evacuation. The use of a portable hyperbaric chamber during military operations to treat acute high-altitude illnesses when descent is not possible will provide an effective treatment modality and reduce the demand on medical treatment facilities as well as reduce the logistical burden of transporting oxygen.

10. In an attempt to determine if triazolam (Halcion) can be used for the treatment of insomnia at altitude, eight healthy non-smoking males participated in each of two trials in a double blind crossover design with ten days between trials. Each trial consisted of one day at sea level (D1) and 2 days (D2, D3) acute exposure to 4300 m in a hypobaric chamber. In trial A (TRI), 0.25 mg of triazolam was administered orally at 2300 hr on D2 and D3. In trial B (CON) a lactose placebo was used. Sleep electroencephalograms, electro-oculograms and electromyograms (2300-0700 hr) were recorded using tin cup electrodes and an Oxford Medilog recorder. Recuperative sleep time (RST) was calculated as total time in sleep stages 2, 3, 4 and REM. There was no difference in mean RST on D1 in CON (392±40 min) as compared to TRI (389±41 min). On D2, RST was significantly increased from 270±82 min in CON to 370±77 min in TRI. On D3 RST was still greater in TRI (373±62 min) as compared to CON (337±59 min), though not statistically significant. It is concluded that 0.25 mg of triazolam is efficacious in the treatment of insomnia resulting from acute exposure to 4300 m.

11. Relevant aeromedical guidelines for aircrew management are lacking when crews are stationed at high terrestrial elevations. Thirteen male subjects ascended in 10 minutes from sea level to 4300 m (simulated), and remained there for 2.5 days. Four times per day subjects completed nine cognitive tests, a mood rating scale, and an acute mountain sickness (AMS) questionnaire. During one test each day, subjects breathed 35% oxygen instead of the ambient hypoxic air. Transient deficits were seen on altitude day one for three cognitive tasks. Most tasks displayed a strong and persistent learning effect. Subjects reporting AMS demonstrated

consistently slower rates of learning and negative changes in mood compared to well subjects. During oxygen administration on altitude day one, performance improved on two cognitive tests and one mood scale. Following rapid ascent to 4300 m, cognitive performance is known to be most affected during the first several hours. Therefore, supplemental oxygen may not be necessary for adequate performance after a period of acclimatization. However, the cognitive and mood effects of AMS, combined with the well-known physical symptoms, suggest that AMS-afflicted aircrew stationed at altitude should be provided an adequate acclimatization period before further air flights.

12. Exposure to high altitude adversely affects nocturnal sleep. However, altitude effects on subsequent daytime sleepiness have not been investigated. A study was performed at 4300 m to address altitude effects on daytime sleepiness as measured by a modified Multiple Sleep Latency Test (MSLT). The effects of nocturnal administration of 0.25 mg triazolam on high-altitude sleep architecture and continuity, subsequent daytime sleep latency and symptom severity of acute mountain sickness (AMS) were also assessed. Using a double blind crossover design, eight healthy male soldiers (ages 19 to 21) were studied in two 4-day "altitude" sessions separated by ten sea-level days. A modified electroencephalogram, electro-oculogram, and electromyogram activity from C3, C4, EMG, EOG were collected throughout each session using Oxford Medilog recorders. On Day 1 (SEA LEVEL), and Days 2, 3, and 4 (ALTITUDE), modified sleep latency tests were conducted at 0950, 1230, 1650, and 1915 hrs. Subjects completed a battery of physiological and behavioral tests and were administered the Environmental Symptoms Questionnaire for assessment of AMS symptom severity. Sleep latency on Day 3 (12.3 min) was significantly longer than latencies for Day 1 (9.3 min) and Day 2 (6.8 min). Analyses failed to reveal any effect of the drug on the latency. Seven of the eight subjects rated their AMS symptoms less severe following triazolam-induced sleep at altitude. The results indicate that, in addition to disrupting normal nocturnal sleep, altitude exposure also interferes with sleep initiation during daytime. However, effects were apparent only after 24 hours at altitude. This suggests that mechanisms involved in poor sleep at altitude include more than an acute hypoxic response.

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14. Crowley, J., N. Wesensten, E.J. Iwanyk, G. Kamimori, P. Amoroso, N. Pearson, T. Balkin. Aeromedical hazards of high terrestrial elevation: Effects of 4300M, acute mountain sickness, and oxygen on cognition and mood. Annual Scientific Meeting of the Aerospace Medical Association, 1991.

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17. Fulco, C.S., K.E. Friedl, and A. Cymerman. The use of dual energy x-ray absorptiometry (DEXA) for the assessment of body composition before and after an altitude exposure. FASEB J. 5:A1127, 1991.

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19. Hoyt, R.W., M.J. Durkot, G.H. Kamimori, D.A. Schoeller, and A. Cymerman. Chronic altitude exposure (4300M) decreases intracellular and total body water in humans. Seventh International Hypoxia Symposium, A55, 1991.

20. Kamimori, G.H., T.J. Balkin, N.J. Wesensten, J. Crowley, N. Pearson, E.J. Iwanyk, and A. Cymerman. The effect of triazolam on sleep architecture during acute exposure to high altitude (4300M). Annual Meeting of the American College of Sports Medicine, 1991.

21. McCullough, R.G., R.E. McCullough, J.G. Zhuang, T. Droma, S.F. Sun, A. Cymerman, J.R. Sutton, G. Rapmund, and L.G. Moore. Increased total lung capacities in Tibetan compared to Han high altitude residents. Seventh International Hypoxia Symposium, 1991.

22. Moore, L.G., J.G. Zhuang, R.G. McCullough, A. Cymerman, T.S. Droma, S.F. Sun, Y. Ping and R.E. McCullough. Increased lung volumes in Tibetan high altitude residents. American Journal Physical Anthropology, 12:341, 1991.

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24. Wesensten, N.J., N. Pearson, T. Balkin, J. Crowley, G.H. Kamimori, E.J. Iwanyk, G. Belenky, and A. Cymerman. Changes in long-latency ERP's during acute hypobaric hypoxia exposure. 31st Annual Meeting of the Society for Psychophysiological Research, 1991.

PRESENTATIONS:

25. Cymerman, A. Current research strategies for the prevention and treatment of altitude illness. Indo-US High Altitude/Cold Weather Scientific Information Exchange. Mysore, India, May 1991.

26. Hoyt, R.W. International Hypoxia Symposia, To present chronic altitude exposure (4300m) decreases intracellular and total body water in humans, Lake Louise, Alberta, Canada, February 1991.

27. Hoyt, R.W. Federation of American Societies of Experimental Biology, To present doubly labeled water (DLW) measurement of human energy expenditure (EE) during a winter climb on Mt. Rainier, Atlanta, Georgia, April 1991.

28. Hoyt, R.W. Nutritional demands of military operations at high terrestrial elevations. Indo-US High Altitude/Cold Weather Scientific Information Exchange. Mysore, India, May 1991.

29. Hoyt, R.W. Prototype soft landing system to improve operational safety of military parachutists. Expert Study Group Meeting on Airborne Troop Lower Limb Protection System, Walter Reed Army Medical Center of Excellence. Washington, D.C., October 1991.

30. Hoyt, R.W. Nutritional ergogenic aids: Carbohydrates and fats. Annual Sports Medicine Meeting, New England Chapter of the American College of Sports Medicine, Marlborough, Massachusetts, November 1991.

31. Iwanyk, E.J. Medical problems at high terrestrial elevation. US Army School of Aviation Medicine, Fort Rucker, Alabama, February 1991.

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33. Iwanyk, E.J. Pharmacological treatment of altitude - induce illnesses. Indo-US High Altitude/Cold Weather Scientific Information Exchange. Mysore, India, May 1991.

34. Iwanyk, E.J. Medical problems at high terrestrial elevation. US Army Research Institute of Environmental Medicine, Natick, MA, May 1991.

35. Iwanyk, E.J. Altitude medicine and military operations at high terrestrial elevations. Naval Underwater Medicine Institute, Groton, Connecticut, August 1991.

36. Iwanyk, E.J. Altitude medicine and military operations at high terrestrial elevation. US Special Operations Command Surgeon's Conference, MacDill Air Force Base, Florida, September 1991.

37. Iwanyk, E.J. Medical problems at high terrestrial elevation, US Army School of Aviation Medicine, Fort Rucker, Alabama, November 1991.

38. Iwanyk, E.J. The medical aspects of cold weather operations, 158th Aviation Regiment, Fort Devens, Massachusetts, December 1991.

SIGNIFICANT TDY:

Allen Cymerman, Ph.D. Indo-US High Altitude/Cold Weather Scientific Information Exchange. To consult with India Ministry of defense officials and scientists on environmental and medical problems occurring in Indian troops stationed at high altitude. Delhi and Mysore, India, May 1991.

Reed W. Hoyt, Ph.D. 1991 Indo-US High Altitude/Cold Weather Scientific Information Exchange, To present Nutritional demands of military operations at high terrestrial elevations. Delhi and Mysore, India, May 1991.

Reed W. Hoyt, Ph.D. To perform energy expenditure measurements for the Ranger Nutrition Assessment Study, Ft. Benning, Georgia, July 1991; Camp Merrill, Delonega, Georgia, August 1991; McGregor Range, Fort Bliss, Texas, September 1991.

Reed W. Hoyt, Ph.D. To present USARIEM soft landing system to reduce injuries during combat parachuting at Expert Study Group Meeting on Airborne Troop Lower Limb Protection System, Walter Reed Army Medical Center, Center of Excellence, Washington, D.C., October 1991.

Reed W. Hoyt, Ph.D. 24 Hour Respirometry Working Group Meeting, To attend educational presentations on whole room respirometry and to establish professional contact with scientists involved in respirometry within the US. French Lick, Indiana, November 1991.

Eugene J. Iwanyk, M.D. 1991 Indo-US High Altitude/Cold Weather Scientific Information Exchange. To consult with India Ministry of defense officials and scientists on environmental and medical problems occurring in Indian troops stationed at high altitude. New Delhi and Mysore, India, May 1991.

SIGNIFICANT VISITORS:

B.G. Blanck, Chief of Professional Services, U.S. Army Medical Department, Natick, MA, October 1991.

PROFESSIONAL APPOINTMENTS/ACTIVITIES:

Cymerman, Allen, Ph.D., Division Chief. Adjunct Associate Professor, Department of Health Sciences, Sargent College of Allied Health Professions, Boston University, Boston, MA. Editorial Board, Wilderness Medical Society.

Hoyt, Reed W., Ph.D. Co-Chair and organizer of the 1991 American Physiological Society Hypoxia Interest Group, Atlanta, Georgia, April, 1991.

Iwanyk, Eugene J., M.D. Aviation Medicine Officer and General Medical Officer, Cutler Army Hospital, Fort Devens, MA.

BIOPHYSICS & BIOMEDICAL MODELING DIVISION

SIGNIFICANT RESEARCH FINDINGS/DEVELOPMENTS:

1. Significant input was contributed to US Army FM 3-4 by the development and addition of computer generated graphical tables displaying tolerance times as a function of the WBGT modified by work intensity in various MOPP configurations.

2. Significant progress was done towards the development of a hand-held environmental heat stress/strain monitor tied in with elements of the USARIEM Heat Strain Model that can be applied in the laboratory and the field.

3. A senior NRC fellow working in the Division developed a thermoregulatory model that includes clothing, central and peripheral circulatory simulations useful for intermittent work.

4. Progress on development of a PC-based feedback microclimate cooling model was accomplished from USARIEM data based studies.

5. As part of the P^2NBC^2 program, an Ada version of the USARIEM Heat Strain Model was developed useful to integrate to Tactical Decision Aid systems.

6. Copper manikin studies were done to ascertain specific differences in thermal characteristics between the Soldier Integrated Protective Ensemble (SIPE) candidates. The candidate SIPE systems were compared to the standard issue uniforms.

7. New clothing coefficients pertinent to Tri-Services standard fielded uniforms were developed using copper manikin heat and water vapor analysis which were added to the clothing menu listing for input to the USARIEM Heat Strain Model.

8. Effects of walking using the articulated copper manikin, while wearing the Battledress Overgarment (BDO), on evaporative and thermal transfer coefficients were completed. When a full regimen of wind speeds, walking rates, and garment types are evaluated for heat exchange coefficients, a useful database will be available for input to the heat strain model.

9. A study was completed on the biophysical evaluation of standard and prototype U.S. Navy extreme cold-weather foot protection systems. It was found that during prolonged vertical immersion in shallow (5cm) water, winter issued boots completely lined with a hydrophilic-polyester membrane showed significantly less reductions in thermal insulation and had less increases in total boot weight when compared to a wide assortment of conventional prototype footwear items.

10. Heat transfer and water vapor transport measurements of materials were evaluated using two different "sweating hot plate" systems from three laboratories: Individual Protection Directorate (Natick), US Navy Clothing and Textile Research Facility and USARIEM. Values were comparable provided variation in air speed over the specific plate is controlled rigorously.

11. A field study was conducted at Fort Bliss, TX sponsored by P^2NBC^2. Under day and night conditions, subjects attempted 6 hour, 12 mile tests with a 45 lb(23 kg) load with different levels of MOPP for a total of five test periods. Physiological, psychological and meteorological data were collected. Maximum individual subject endurance time in MOPP 4 with the 45 lb load and moderate work activity during a daylight test period was 204 min.

12. A pilot study was conducted to determine a method for measuring surface skin blood flow in volunteer subjects wearing military handwear. These results will be added towards continual development of a cold stress operational model useful for monitoring troop cold injury prevention.

13. A study addressing air velocity profiles surrounding a life-size copper manikin was investigated. Air velocity profiles for different posture modes (sitting and standing) were characterized. The potential coefficients will be applied in a prediction model development of heat exchange for different soldier stations.

PUBLICATIONS:

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2. Chang, S.KW. and R.R. Gonzalez. Air velocity mapping of environmental test chambers. ASHRAE Trans, 97:31-36, 1991.

3. Chang, S.KW. Data acquisition system for collection of biophysical and physiological data. USARIEM Technical Report No.T9-91, 1991.

4. Gibson, P., T. Endrusick and J. Giblo. Comparative study of heat transfer and water vapor permeability at three laboratories. Technical Report Natick/TR-91/029, 1991.

5. Kraning, K.K. Temperature Regulation and the Skin. In: Physiology, Biochemistry and Molecular Biology of the Skin. 2nd Edition. L.A. Goldsmith (Ed.), Oxford University Press, London, 1991, pp.1085-1095.

6. Kraning, K.K. and R.R. Gonzalez. Physiological consequences of intermittent exercise during uncompensable heat stress. J. Appl. Physiol., 71:2138-2145, 1991.

7. Kraning, K.K. and R.R. Gonzalez. Physiological responses to intermittent exercise as modified by heat stress and protective clothing. USARIEM Technical Report No. T12-91, 1991.

8. Kraning, K.K. A computer simulation for predicting the time course of thermal and cardiovascular responses to various combinations of heat stress, clothing and exercise. USARIEM Technical Report No. T13-91, 1991.

9. Matthew, W.T. and W.R. Santee. Potential Heat Casualty Risk Assessment in Southwest Asia: Weather Data Requirements in the Spatial Domain. In: Proceedings of the Eleventh Annual Electro Optical Systems Atmospheric Effects/Tactical Weather Intelligence Conference (EOSAEL/TWI), 315-324, 1991.

10. Shitzer, A., L.A. Stroschein, W.R. Santee, R.R. Gonzalez and K.B. Pandolf. Quantification of Endurance Times of Fingers Exposed to Cold Weather Conditions. In: Proceedings of the International Symposium on Heat and Mass Transfer in Biomedical Engineering. K.R. Diller (Ed.). Hemisphere Publishing Corporation, Washington, D.C. (In Press).

11. Shitzer, A., L.A. Stroschein, W.R. Santee, R.R. Gonzalez and K.B. Pandolf. Quantification of conservative endurance times in thermally insulated, cold stressed digits. J. Appl. Physiol. 71:2528-2535, 1991.

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PRESENTATIONS:

13. Stephen KW. Chang, Clothing insulation prediction in hypobaric environments. Fourth International Symposium on the Performance of Protective Clothing: Challenges for Developing Protective Clothing for the 1990's and Beyond, Montreal, Quebec, Canada, 18-20 June 1991 .

14. Thomas L. Endrusick. Physiological responses while wearing protective footwear in a cold-wet environment. Fourth International Symposium on the Performance of Protective Clothing: Challenges for Developing Protective Clothing for the 1990's and Beyond, Montreal, Quebec, Canada, 18-20 June 1991.

15. Richard R. Gonzalez, Ph.D. Physiological and biophysical properties of a semipermeable attached hood to a chemical protective garment. Fourth International Symposium on the Performance of Protective Clothing: Challenges for Developing Protective Clothing for the 1990's and Beyond, Montreal, Quebec, Canada, 18-20 June 1991.

16. William R. Santee, Ph.D. Comparative responses to exercise-heat stress of two chemical protective garments. Fourth International Symposium on the Performance of Protective Clothing: Challenges for Developing Protective Clothing for the 1990's and Beyond, Montreal, Quebec, Canada, 18-20 June 1991.

KEY BRIEFING:

17. William R. Santee, Ph.D. To the JWG on Chemical Protective Overgarments a briefing on the USARIEM study of the MK-IV Ensemble, Natick RD&E Center, 29 January 1991.

SIGNIFICANT TDY:

William T. Matthew. To attend/participate in the 1991 Mission Area Materiel Plan (MAMP) Conference, Frederick, MD hosted by U.S. Army Medical Materiel Development Activity (USAMMDA), July 1991.

William T. Matthew. To attend a conference entitled, "Artificial Intelligence and Simulation in Modeling Complex Systems", Falls Church, VA hosted by the Army High Performance Computing Research Center (AHPCRC), July 1991.

William T. Matthew. To participate in a design review meeting on the Army environmental Heat Stress Monitor (HSM), San Antonio, Texas hosted by Southwest Research Institute, San Antonio, TX, November 1991.

William T. Matthew and William Santee, Ph.D. To attend and participate in the Battlefield Atmospherics Conference, Fort Bliss, TX, sponsored by the U.S. Army Atmospheric Sciences Laboratory, November 1991.

William R. Santee, Ph.D. To attend the NATO RSG 20/Panel VIII meeting on "Modeling responses to cold exposure" in Copenhagen, Denmark, and present a summary of USARIEM handwear studies and a finger temperature and endurance model, March 1991.

Robert F. Wallace. To attend the "Tri-Ada '91" conference at San Jose, CA, October 1991.

Twelve staff scientists and personnel to participate in a P^2NBC^2 heat stress field study, Fort Bliss, TX, August 1991.

PROFESSIONAL APPOINTMENTS/ACTIVITIES:

Gonzalez, Richard R., Ph.D., Division Chief. Adjunct Professor of Environmental Science & Physiology, Harvard School of Public Health, Boston, MA. Advisor, NAS/NRC Research Associateship Program. American Society Heating Refrigeration Air-conditioning Engineers, Member, Standards Committee and Technical Consultant, Thermodynamics and Psychometrics Committee (TC 1.1), Physiology and the Human Environment Committee (TC 2.1), Standards Preparation Committee (SPC 55-81R), Technical Committee 1.1, "Thermodynamics and Psychometrics", Standards Committee Intersociety Representative to International Standards Organization (ISO), Technical Committee 59 "Ergonomics". Federation of American Societies for Experimental Biologists (FASEB), Washington, D.C. Minority Schools Lecturer Roster. Member, NATO Research Study Group (RSG) 20, "Modeling in Cold Environments", Brussels, Belgium. Reviewer, Science, American Journal of Physiology, Journal of Applied Physiology, and Aviation, Space and Environmental Medicine.

Matthew, William T. Member, Integrated Logistical Support (ILS) Management Team for Army Environmental Heat Stress Monitor (HSM). Participant, Soldier System Architecture (SSA) Working Group.

THERMAL PHYSIOLOGY AND MEDICINE DIVISION

SIGNIFICANT RESEARCH FINDINGS/DEVELOPMENTS:

1. A study was conducted to determine if: (a) exhaustion from heat strain occurs at the same body temperatures during exercise in the heat when subjects are euhydrated as when they are hypohydrated; (b) aerobic fitness influences the body temperature at which exhaustion from heat strain occurs; and (c) curves could be developed to estimate exhaustion rates at a given level of physiological strain. Seventeen heat acclimated men ($\dot{V}o_2max$ from 45 to 65 $ml \cdot kg^{-1} \cdot min^{-1}$) attempted two Heat Stress Tests (HSTs): one when euhydrated and one when hypohydrated by 8% of total body water. The HSTs consisted of 180 minutes of rest and treadmill walking (45% $\dot{V}o_2max$) in a hot-dry (Ta=49°C, rh=20%) environment. The required evaporative cooling (E_{req}) exceeded the maximal evaporative cooling capacity of the environment (E_{max}); thus, thermal equilibrium could not be achieved and 27 of 34 HSTs ended by exhaustion from heat strain. Our findings concerning exhaustion from heat strain are: 1) hypohydration reduced the core temperature that could be tolerated; 2) aerobic fitness, per se, did not influence the magnitude of heat strain that could be tolerated; 3) curves can be developed to estimate exhaustion rates for a given level of physiological strain; and 4) exhaustion was rarely associated with a core temperature up to 38°C and exhaustion always occurred before achieving 40°C. These findings are applicable to heat acclimated individuals performing moderate intensity exercise under conditions where E_{req} approximates or exceeds E_{max}, and who have high skin temperatures.

2. The role of the increase in body temperature normally experienced during exercise was studied to identify adaptations produced by endurance exercise training. We hypothesized that preventing this rise in body temperature, as might occur if exercise was performed in cold environments, would alter the efficacy of training for improving aerobic capacity. Eighteen men completed 8 weeks of training consisting of 60-min cycling exercise while immersed in either hot (9 men) or cold (9 men) water. The rationale was that individuals exercising in cold water would experience no rise

in body temperature during training, while those exercising in hot water would experience a large increase. During training sessions, subjects exercising in hot water experienced more than a 1 °C rise in rectal temperature while those exercise in cold water experienced no significant rise in rectal temperature. Before and after completing the training program, each subject completed an assessment of maximal aerobic capacity, blood volume and thermoregulatory and metabolic responses to 60-min steady-state exercise in hot (35 °C) and, on a separate day, cold (20 °C) water. Training increased maximal aerobic capacity by about 13% in both groups, with no difference in the magnitude of training effect between groups. Both groups experienced a similar, small increase in erythrocyte volume during training with no change in plasma volume. Lactate accumulation and muscle glycogen utilization during steady-state exercise were reduced following training, with no effect of the water temperature during training on the magnitude of the effect. Thermoregulatory response data are still being analyzed. These findings indicate that the efficacy of endurance training programs for improving aerobic capacity is similar whether the exercise programs are performed in cold or warm environmental conditions.

3. Recently it has been reported that esophageal temperature (T_{es}) is a more responsive index of circadian core temperature than rectal temperature. For this reason, T_{es} was measured during sleep to examine its relationship to REM sleep. Subjects were four males, ages 18-23. Ambient temperature was maintained in their subjective comfort zones. Subjects were monitored during two baseline nights, were then sleep deprived under supervision for 40-46 h, and then had two *ad lib* recovery nights of sleep. During the sleep periods, T_{es} was measured each min; and sleep EEG, EOG and EMG were recorded continuously. Sleep records were then scored by 30 s epoch according to the criteria of Rechtschaffen and Kales. Data from the second baseline control night (CON) and the first of the two recovery nights (REC) were analyzed. The T_{es} curves developed in a series of plateaus and discontinuities across the individual study nights, rather than in the previously reported relatively smooth ascending and descending limbs. During both CON and REC, the onset of REM sleep was invariably anticipated by phasic downturn in T_{es} which then continued for

several minutes beyond the onset of REM sleep. The expectation, based upon T_{re}, is a synchrony between REM sleep onset and phasic core temperature increase above the moving circadian baseline. Only when REM sleep was fully developed did T_{es} demonstrate the expected REM-related increase. The upward movement of T_{es} then continued for varying lengths of time beyond the turn-around point. The mean total time elapsed from onset of the pre-REM T_{es} decrease until T_{es} reversed its direction upward and was in the range consistent with the difference in relative responsiveness between T_{es} and T_{re}. In no case did T_{es} begin its ascent with the onset of REM sleep. In all cases, the ascending limb of the phasic REM-related T_{es} curve began well beyond the beginning of the REM period. Previous understanding of the association between core temperature and REM sleep has been biased by the slow response time of T_{re} measurements. The temperature rise which to this time has been assumed to occur coincidently with REM sleep in fact began well past the onset of REM sleep when temperature was measured in the esophagus. Further, there was a phasic downturn in core temperature in anticipation of REM onset. These findings suggest that core temperature changes during REM sleep, and the association of the hypothetical REM and circadian core temperature oscillators, warrant more critical study.

4. Pyridostigmine bromide is used by the U.S. Army as a pre-treatment for anticipated nerve agent challenge in soldiers deployed to high risk areas. Two separate studies of multiple dose (30 mg, t.i.d.) pyridostigmine ingestion were completed at the U.S. Army Research Institute of Environmental Medicine. In STUDY 1, five subjects were studied at rest in a hot environment (35 °C) in 1) a control experiment; 2) two hours after 30 mg pyridostigmine per os; and 3) 50 hours after the initial 30 mg pyridostigmine but 2 hours after the seventh and final 30 mg tablet was ingested. In STUDY 2, four subjects were studied in a warm environment (31 °C) in 2) a control experiment at sea level; 2) a control experiment at 10,000 feet (522 Torr); 3) at 10,000 feet, two hours after 30 mg pyridostigmine per os; 4) at 10,000 feet 26 hours after the initial pyridostigmine tablet, but 2 hours after the fourth pyridostigmine tablet was ingested; and 5) at sea level 74 hours after the first pyridostigmine tablet and 2 hours after the 10th and final pyridostigmine tablet. The control and

treatment experiments were run at the same time of day for both studies. In all experiments, esophageal temperature (T_{es}), heart rate, arterial blood pressure, forearm blood flow (FBF) and forearm skin blood flow (SkBF) were measured. Red blood cell cholinesterase activity was used as an index of pyridostigmine effectiveness. Mean red blood cell cholinesterase activity was inhibited between 31 and 47%. In STUDY 1, resting T_{es} and heart rate were lower after 50 hours of pyridostigmine ingestion compared to control (36.60±0.08°C vs 36.82±0.08°C; 58±11 $b \cdot min^{-1}$ vs 69±13 $b \cdot min^{-1}$, $p<0.05$). In STUDY 2, T_{es} was lower at altitude (36.60±0.06°C vs 36.84±0.14°C, $p<0.05$) and tended to be lower after 74 hours of pyridostigmine treatment (36.75±0.15) at sea level compared to control. Heart rate was lower at sea level after 74 hours of pyridostigmine (60±8 $b \cdot min^{-1}$ vs 68±14, $p<0.05$). It appears that multiple low dose pyridostigmine bromide subtly lowers resting heart rate and core temperature in a hot environment and lowers resting heart rate in a warm environment. The effect on heart rate can probably be explained by cholinergic (vagal) stimulation, whereas the effect on core temperature is unexplained.

5. Thermoregulatory responses induced by the currently fielded chemical protective Battle Dress Overgarment (BDO) or the prototype Chemical Protective Underwear (CPU) were compared in 10 volunteer soldiers in the laboratory and 14 in the field. In the laboratory study, the garments were compared in three environments: 32°C/50% RH, 38°C/30% RH, and 24°C/80% RH. Volunteers were monitored for rectal and skin temperatures, heart rate and sweating rate. On separate test days, the volunteers wore the chemical protective garments in MOPP 2 and MOPP 4, during rest and treadmill walking, for up to 3 hours. When the BDO was worn over the duty uniform (either Desert Battle Dress Uniform or Combat Vehicle Crewman Coverall) responses were more pronounced than when the duty uniform was worn over the CPU. When the BDO was worn without the duty uniform (over standard underwear alone), responses were similar to the duty uniform plus CPU. In the field study (Yuma Proving Ground, AZ, July: ~34°C/20% RH) volunteers exercised for up to 4 hours, roadwalking for 30 min alternated with seated rest for 15 min while rectal temperature, heart rate and sweating rate were monitored. The BDO over standard underwear alone was worn on one day and the duty uniform was

worn over CPU on the counterbalancing day. The physiological responses did not differ, confirming the results of the laboratory test. In both studies the soldiers volunteered that the duty uniform plus CPU ensemble was more comfortable than wearing the BDO. In addition to the USARIEM data collection in the field study, WRAIR implemented a separate research protocol to validate core temperature data collected by telemetry from their "temperature pill" against the USARIEM rectal temperature data.

6. Fifty-one male soldiers with a mean age of 22 (range 18 to 35) years and maximal aerobic power of 53 (range 42 to 65) $ml \cdot kg^{-1} \cdot min^{-1}$ had their lean body mass and vascular fluid volumes measured. The primary purpose was to develop a normative data base for the erythrocyte volume, plasma volume and blood volume of healthy, young men. The secondary purposes were to relate these vascular fluid volumes to the person's body size and physical fitness level and to develop regression equations which enables their accurate prediction. Erythrocyte volume was measured by ^{51}Cr for all subjects; plasma volume was measured by ^{125}I for forty-three subjects and calculated (F-Cell of 0.89) from the erythrocyte volume and venous hematocrit for eight subjects. The findings concerning the erythrocyte volume, plasma volume and blood volume of young men are summarized as follows: 1) the accurate prediction of these vascular fluid volumes can be made from several indices of body size; 2) lean body mass is the body size index which is best related to these vascular fluid volumes; 3) aerobic fitness does not influence these vascular fluid volumes in individuals not recently participating in intense physical training; and 4) F-Cell ratio is not related to aerobic fitness.

PUBLICATIONS:

1. Bandick, N.R. and D.E. Roberts. Intrinsic alteration of the reactive properties of arteries during hypothermia. Cryobiology 28:499-502, 1991.

2. Bruttig, S.P. and D.E. Roberts. Cold induced changes in arterial sensitivity. USARIEM Technical Report T11-91, 1991.

3. Cadarette, B.S., W.A. Latzka, L. Levine and M.N. Sawka. A physiological evaluation of a prototype air-vest microclimate cooling system. USARIEM Technical Report T14-91, 1991.

4. Cook, J.E., M.A. Kolka and C.B. Wenger. Chronic pyridostigmine bromide administration: Side effects among soldiers working in a desert environment. Mil. Med. (In Press), 1991.

5. Kolka, M.A., P.W. Burgoon, M.D. Quigley and L.A. Stephenson. Red blood cell cholinesterase activity and plasma pyridostigmine concentration during single and multiple dose studies. USARIEM Technical Report T3-91, 1991.

6. Kolka, M.A., P.W. Burgoon and L.A. Stephenson. Multiple dose pyridostigmine administration: Cardiovascular effects at rest during acute heat and altitude exposure. USARIEM Technical Report T1-92, 1991.

7. Kolka, M.A. Heat Acclimation. Intermittent High Intensity Exercise; Proceedings of the Rugby World Cup Sports Medicine Congress, Edinburgh, Scotland, 1991. Hampshire: Routledge, Chapman and Hall, (In Press), 1991.

8. Kolka, M.A. Temperature regulation and heat stress in women. Med., Nutr., Exerc. and Health 1: (In Press), 1991.

9. Levine, L., M.A. Kolka, B.S. Cadarette and W.A. Latzka. Respiratory and skeletal muscle function after acute pyridostigmine bromide administration. USARIEM Technical Report T2-91, 1991.

10. Levine, L., M.S. Rose, R.P. Francesconi, P.D. Neufer and M.N. Sawka. Fluid replacement during sustained exercise in the heat: Nutrient solution vs. water. Aviat. Space Environ. Med. 62:559-564, 1991.

11. Neufer, P.D., M.N. Sawka, A.J. Young, M.D. Quigley, W.A. Latzka and L. Levine. Hypohydration does not influence skeletal muscle glycogen resynthesis after exercise. J. Appl. Physiol. 70:1490-1494, 1991.

12. Prusaczyk, W.K. and M.N. Sawka. Effects of pyridostigmine bromide on human thermoregulation during cold-water immersion. J. Appl. Physiol. 71:432-437, 1991.

13. Reeves, J.T., E.E. Wolfel, H.J. Green, M.S. Mazzeo, A.J. Young, J.R. Sutton and G.A. Brooks. Oxygen transport during exercise at high altitude and the lactate paradox: lessons from Operation Everest II and Pikes Peak. In: Exercise and Sport Sciences Reviews, J.O. Holloszy (ed.), Baltimore: Williams and Wilkens (In Press), 1991.

14. Sawka, M.N. and K.B. Pandolf. Upper body exercise: Physiology and training applications for human presence in space. Proceedings 21st International Conference on Environmental Systems. Warrendale, PA:SAE International, MS #911461, 1-20, 1991.

15. Sawka, M.N., C.B. Wenger, A.J. Young and K.B. Pandolf. Physiological responses to exercise in the heat. In: Nutritional Requirements in a Hot Environment. Washington, DC: Food and Nutrition Board, Institute of Medicine, National Academy of Sciences, (In Press), 1991.

16. Sawka, M.N., W.A. Latzka and K.B. Pandolf. Upper body exercise: Application for wheelchair propulsion and spinal injured populations. In: Proceedings International Workshop on Manual Wheelchairs. Amsterdam: Vrije University Press, 95-103, 1991.

17. Sawka, M.N. and J.E. Greenleaf. Current concepts concerning thirst, dehydration and fluid replacement: Overview. Med. Sci. Sports Exerc., (In Press), 1991.

18. Sawka, M.N. Physiological consequences of hypohydration: Body water redistribution, exercise performance and temperature regulation. Med. Sci. Sports Exerc. (In Press), 1991.

19. Sawka, M.N., A.J. Young, K.B. Pandolf, R.C. Dennis and C.R. Valeri. Erythrocyte, plasma and blood volume of healthy young men. Med Sci. Sports Exerc. (In Press), 1991.

20. Stephenson, L.A., B.S. Cadarette, T.L. Endrusick, M.D. Quigley and P.B. Rock. Biophysical and physiological evaluation of the individual chemical threat agent protective patient wrap. USARIEM Technical Report T6-91, 1991.

21. Wenger, C.B. and W.A. Latzka. Effects of pyridostigmine bromide on physiological responses to heat, exercise and hypohydration. Aviat. Space Environ. Med. (In Press), 1991.

22. Wenger, C.B., M.D. Quigley and M.A. Kolka. Pyridostigmine Bromide: Effects on Physiological Responses to Repeated Exercise-Heat Stress. In: Proceedings of the 1991 Medical Defense Bioscience Review, pp. 381-384, 1991.

23. Young, A.J., P.M. Young, R.E. McCullough, L.G. Moore, A. Cymerman and J.T. Reeves. Effect of beta-adrenergic blockage of plasma lactate concentration during exercise at high altitude. Eur. J. Appl. Physiol. 63:315-322, 1991.

24. Young, A.J. Effects of aging on human cold tolerance. Exp. Aging Res. 17:205-213, 1991.

ABSTRACTS:

25. Agnew, J.W., B.J. Freund, D.A. DuBose, J.M. McKay and G.M. Hashiro. The role of atrial natriuretic peptide (ANP) in cold-induced diuresis (CID). FASEB J. 5:A134, 1991.

26. Blanchard, L.A., M.A. Kolka and L.A. Stephenson. Comparison of rectal, esophageal and pill temperature as a circadian core temperature indicator in humans. FASEB J. 5:A1125, 1991.

27. Cadarette, B.S., W.K. Prusaczyk and M.N. Sawka. Influence of pyridostigmine bromide on human thermoregulation during cold water immersion. FASEB J. 5:A393, 1991.

28. Kolka, M.A. and L.A. Stephenson. Chest and forearm blood flow responses during exercise in a warm environment. FASEB J. 5:A1400, 1991.

29. Lindsley, J.G., L. Levine, M.A. Kolka and L.A. Stephenson. Esophageal temperature decrease anticipates REM sleep onset. Sleep Res. 20A:546, 1991.

30. Quigley, M.D., W.K. Prusaczyk, P.W. Burgoon and M.N. Sawka. Influence of load carriage on ventilation and acid-base equilibrium during exercise. Med. Sci. Sports Exerc. 22:S96, 1991.

31. Sawka, M.N. and J. E. Greenleaf. Current concepts concerning thirst, dehydration and fluid replacement. Med. Sci. Sports Exerc. 22:S1, 1991.

32. Wenger, C.B., M.D. Quigley and M.A. Kolka. Chronic pyridostigmine bromide: Effects on physiological responses to repeated exercise-heat stress. In: Proceedings of the Eighth Chemical Defense Bioscience Review, 1991.

33. Young, A.J., M.N. Sawka, M.D. Quigley, P.W. Burgoon, B.S.Cadarette and K.B.Pandolf. Improvements in aerobic capacity achieved by endurance training in hot versus cold water. Med. Sci. Sports Exerc. 22:S153, 1991.

34. Young, A.J., M.N. Sawka, P.W. Burgoon, L. Levine, M.D. Quigley, W.A. Latzka and K.B. Pandolf. The role of thermal factors for training-induced adaptations in metabolic responses to exercise. FASEB J. 4:A661, 1991.

PRESENTATIONS:

35. Kolka, M.A. Heat acclimation. Sports Medicine Congress, Edinburgh, Scotland, October 1991.

36. Sawka, M.N. Physiological responses to heat stress. Symposium on Nutritional Requirements in Hot Environments, National Academy of Sciences, Washington, DC, April 1991.

37. Sawka, M.N. Survey of research in exercise-environmental physiology. The Pennsylvania State University, University Park, PA, April 1991.

38. Sawka, M.N. Physiological consequences of hypohydration: exercise performance and thermoregulation. Symposium on Current Concepts Concerning Thirst, Dehydration and Fluid Replacement, American College of Sports Medicine Meeting, Orlando, FL, May 1991.

39. Sawka, M.N. Upper body exercise: physiology and training applications for human presence in space. Symposium on Exercise Countermeasures in Permanent Human Space Presence. International Conference on Environmental Systems, San Francisco, CA, July 1991.

40. Sawka, M.N. Upper body exercise: application for wheelchair propulsion and spinal cord injured populations. International Symposium on the Ergonomics of Manual Wheelchair Propulsion, Vrije University, Amsterdam, Netherlands, October 1991.

41. Sawka, M.N. Cardiovascular adaptations to exercise. Massachusetts General Hospital, Boston, MA, November 1991.

42. Young, A.J. Effects of water temperature on the physical training response. Invited presentation in the Symposium on Metabolic Responses to Rest and Exercise in Cold Water, American College of Sports Medicine Meeting, Orlando, FL, May 1991.

43. Young, A.J. Can you enhance capacity for performance in the cold? Invited presentation in the Symposium on Enhancing Performance for Wilderness Adventure, First World Congress on Wilderness Medicine, sponsored by the Wilderness Medical Society, Whistler, British Columbia, Canada, July 1991.

44. Young, A.J. Physiological effects of high altitude and cold on humans. Invited seminar at Harvard University, Boston, MA, 21 October 1991.

45. Young, A.J. Physiological responses to exercise at high altitude in heat and in cold. Sargent College of Allied Health Professions, Boston University, Boston, MA, December 1991.

KEY BRIEFINGS:

46. James E. Cook, CPT, MC. Cold injuries and altitude medicine. U.S. Air Force Global Medicine Course - Instructor - Brooks Air Force Base, San Antonio, TX, March 1991.

47. James E. Cook, CPT, MC. Cold injuries and Antarctic operations. Antarctic Squadron VXE-6 Safety Standown - Lecturer - Point Mugu Naval Air Station, Point Mugu, CA, July 1991.

48. James E. Cook, CPT, MC. Cold injuries and military operations. U.S. Army Flight Surgeon Primary Course - Instructor -School of Aviation Medicine, Fort Rucker, AL, July and November 1991.

49. Margaret A. Kolka, Ph.D. Multi-chambered Autoinjector Steering Committee meeting on animal trials. Edgewood, MD, February 1991.

50. Margaret A. Kolka, Ph.D. Multi-chambered Autoinjector Steering Committee In-Process Review Meeting. U.S. Army Medical Materiel Development Activity, Ft. Detrick, MD, November 1991.

51. Michael N. Sawka, Ph.D. Health hazard assessment of thermal problems. U.S. Army Medical Research and Development Command, Fort Detrick, Frederick, MD, November 1991.

SIGNIFICANT TDY:

James E. Cook, CPT, MC. Airborne Training, Fort Benning, GA, May 1991.

James E. Cook, CPT, MC. To attend Preventive Medicine Officers Symposium, Falls Church, VA, September 1991.

James E. Cook, CPT, MC. To collaborate in study, "Heat injury among Marine recruits" with Walter Reed Army Institute of Research and the Uniformed Services University of the Health Sciences. Parris Island, SC, November 1991.

Beau J. Freund, CPT, MS. To speak at the DOD Human Factors Testing and Evaluation Subgroup Meeting, San Diego, CA, 1-5 April 1991.

Beau J. Freund, CPT, MS. To participate as a co-investigator in a collaborative research project "The Effects on Extreme Hyperbaria on Exercise Performance," Geesthacht, Germany, 21 May - 11 June 1991.

Beau J. Freund, CPT, MS. Attended and completed SensorMedics operators training course on the 2900 Metabolic Measurement Cart, Yorba Linda, CA, 12-20 October 1991.

Margaret A. Kolka, Ph.D. Coordinate with U.S. Army Environmental Hygiene Agency and Office of The Surgeon General on information required from U.S. Army Natick Research, Development and Engineering Center clothing evaluations. U.S. Army Environmental Hygiene Agency, Edgewood, MD, January 1991.

C. Bruce Wenger, M.D., Ph.D. To collaborate in study, "Heat Injury Among Marine Recruits" with Walter Reed Army Institute of Research and the Uniformed Services University of the Health Sciences. Beaufort, SC, May 1991; July 1991; September 1991. Bethesda, MD, November 1991.

Andrew J. Young, Ph.D. To participate in the 31st meeting of Working Party 61 of the Air Standardization Coordinating Committee, RAF Institute of Aviation Medicine, Farnborough, England, October 1991.

PROFESSIONAL APPOINTMENTS/ACTIVITIES:

Michael N. Sawka, Ph.D., Division Chief. Advisory Board, Center of Excellence for Cardiovascular Studies, Graduate Hospital System, Philadelphia, PA; Editorial Board, Aviation, Space and Environmental Medicine; Editorial Board, Journal of Applied Physiology; 1991-1993; Member, Nuclear Biological Chemical Protective Equipment Subgroup, Chemical Defense Technical Cooperation Program. Member, Physiological and Psychological Effects of Nuclear, Biological and Chemical and Sustained Operations on Systems in Combat Program (P^2NBC^2) Scientific Advisory Group; Member, Soldier Integrated

Protective Ensemble (SIPE) Program, Test and Evaluation Subgroup; Chairman, Project Review Committee, American College of Sports Medicine. Member, Position Statement Writing Committee on Fluid Replacement During Exercise, American College of Sports Medicine; Associate Professor, Institute of Health Professions, Massachusetts General Hospital, Boston, MA; Reviewer, American Journal of Physiology; European Journal of Applied Physiology; International Journal of Sports Nutrition; International Journal of Sports Medicine; Medicine and Science in Sports and Exercise; Research Quarterly for Exercise and Sport, Sports Medicine; The Physician and Sportsmedicine; The Journal of Cardiorespiratory Rehabilitation.

Beau J. Freund, CPT, MS. Fellow, American College of Sports Medicine; Affiliate Graduate Faculty Member, John A. Burns School of Medicine, University of Hawaii; Guest Reviewer, Journal of Applied Physiology; American Journal of Physiology.

Margaret A. Kolka, Ph.D. Member, U.S. Army Medical Research and Development Command Steering Committee for Multichambered Autoinjector; Member, Scientific Review Committee. Guest Reviewer, European Journal of Applied Physiology; Journal of Applied Physiology; American Journal of Physiology (Reg. Int., Comp. Physiol.; American Journal of Physiology (Heart and Circul.)

Lou A. Stephenson, Ph.D. Guest Reviewer, Journal of Applied Physiology; American Journal of Physiology.

C. Bruce Wenger, M.D., Ph.D. Member, Subcommittee C95.1-IV, Working Group 11 (Metabolism/Thermoregulation), American National Standards Institute, New York, NY; Guest Reviewer, American Journal of Physiology; Medicine and Science in Sports and Exercise; Canadian Journal of Physiology and Pharmacology.

Andrew J. Young, Ph.D. U.S. Army Project Officer, Project Group 114, Aeromedical Considerations of Thermal Stress and Survival, Working Party 61, Air Standardization Coordinating Committee; Adjunct Lecturer, Department of Physical Therapy, Institute of Health Professions, Massachusetts General Hospital, Boston, MA; Editorial Board, Medicine and Science in Sports and Exercise; Member, Research Review Committee,

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American College of Sports Medicine, Indianapolis, IN; Guest Reviewer, Medicine and Science in Sports and Exercise; Journal of Applied Physiology; Arctic; Aviation, Space and Environmental Medicine.

OCCUPATIONAL HEALTH & PERFORMANCE DIRECTORATE

RESEARCH FINDINGS: EXECUTIVE SUMMARY

- Validated an improved body fat estimation model which is more reliable and accurate than underwater weighing by accounting for variable bone mineral and water components.

- Confirmed that musculoskeletal injuries are the leading cause of limited duty days among infantry soldiers, with the least physically fit soldiers more likely to sustain injuries from daily training and events such as road marches.

- Conducted an operational evaluation of the Arctic Tray Ration; a cold weather energy supplement; the Meal, Ready-to-Eat (MRE); and the Long Life Ration Packet (LLRP) at Fort Greely, AK, in support of a new cold weather feeding policy.

- Demonstrated that nimodopine improves memory and increases brain acetylcholine release and identified a new class of drugs that may similarly enhance performance, muscarinic-type 2 antagonists.

- Demonstrated that target detection during simulated sentry duty is improved by caffeine, a mild stimulant.

- Developed a plan for the USMC to improve nutrition in the Officer Candidate Course; found the need for improved nutritional knowledge in USMC Officer Candidates.

- Demonstrated that rifle marksmanship is impaired by exposure to ambient heat (95°F), the wearing of combat chemical protective clothing (MOPP-IV), use of medications (antihistamines and nerve agent antidotes), and by sentry duty (vigilance) conditions.

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- Documented that soldiers who smoke cigarettes are 1.5 - 2.0 times more likely to be injured during physical training than non-smokers, depending on how much they smoke.

- Documented that trainees in the nine week Ranger School training course lost more than 10% of body weight, largely fat mass, in response to a average caloric deficit of 1500 kcal/day. Nutritional status was normal but immune function was reduced significantly, coinciding with increased infection rate.

- Studies of team tasks that involve heavy lifting and/or carrying have demonstrated that modifications to equipment will enhance performance for teams of women or mixed gender, as demonstrated with harness systems for stretcher carrying.

PUBLICATIONS:

1. Vogel, J.A. Research initiatives in training related musculoskeletal injuries. Journal of the U.S. Army Medical Department. Jan/Feb: 20-22, 1991.

2. Vogel, J.A. Obesity and its relation to physical fitness in the U.S. Military. Armed Forces & Society. (In Press).

3. Vogel, J.A. and K.E. Friedl. Army Data: Body composition and physical capacity. In: Proceedings of the National Academy of Science Conference on Body Composition and Physical Performance. (In Press).

4. Vogel, J.A., B.H. Jones, P.B. Rock, and G. Havenith. Environmental considerations in exercise testing and training. In: ACSM Resource Manual Guidelines for Exercise Testing and Training, Lea and Febringer, Philadelphia. (In Press).

ABSTRACTS:

5. Vogel, J.A., K.E. Friedl, W.L. Daniels and P.I. Fitzgerald. How useful is body composition in the prediction of lift strength and aerobic capacity? Med. Sci. Sports Exercise. 23:S47, 1991.

PRESENTATIONS:

6. Vogel, J.A. Physical fitness research and policy issues. Advanced Course, Army War College. Carlisle Barracks, PA, 15 April 1991.

7. Vogel, J.A. Introduction to Panel on: Human factors engineering and ergonomics - Are physiologists and psychologists really collaborating? DoD Human Factors Engineering Technical Group Meeting. Natick, MA, 16 May 1991.

8. Vogel, J.A. Introduction to Symposium on: Backpacking for work and recreation. New England American College of Sports Medicine Conference. Marlboro, MA, 7 November 1991.

SIGNIFICANT TDY:

James A. Vogel, Ph.D. Attend and chair the fourth meeting of NATO Panel 8, Research Study Group 17, "Biomedical Aspects of Military Training". Edmonton, Alberta, Canada, 1-5 July 1991.

PROFESSIONAL APPOINTMENTS/ACTIVITIES:

Vogel, James A., Ph.D., Research Director. Adjunct Professor, Dept. of Health Sciences, Boston University. Chairman, NATO Research Study Group on Biomedical Aspects of Physical Training. Chairman, Credentials Committee, American College of Sports Medicine. Trustee, New England Chapter of American College of Sports Medicine. Member, Commonwealth of Massachusetts Criminal Justice Training Council Advisory Panel on Health and Physical Fitness. Member, Army Counterpart Panel on Board of Army Science and Technology Study of Strategic Technologies (BLAST-STAR). Member, Army Planning

Committee for Physical Fitness. Member, Army Surgeon General's SES Performance Review Board. U.S. Army Member to The Technical Cooperation Program (TTCP), Subgroup U, Action Group 12, "Physical Performance Enhancement of Elite Combat Units". Associate Editor, Journal of Applied Sports Sciences.

MILITARY NUTRITION DIVISION

SIGNIFICANT RESEARCH FINDINGS/DEVELOPMENTS:

1. USARIEM is the lead laboratory for medical testing of the capability of the Army Field Feeding System (AFFS) to deliver adequate nutrition to soldiers operating in environmental extremes. Complete testing of the AFFS in a cold climate was required by the combat developer to test, modify and develop doctrine, for which a series of three sub-tests was mandated. The first two sub-tests were conducted in 1989 and 1990, respectively. The first sub-test was designed to determine the adequacy of the Meal, Ready-to-Eat (MRE) for cold weather operations. A calorie supplement for the MRE (3MREs + Supplement) was tested and found to be superior to simply issuing an additional MRE (4MREs) to meet cold weather energy requirements. The supplemented MRE was compared against a new dehydrated Ration, Cold Weather (RCW) in the second sub-test. Both rations were satisfactory. The third sub-test, conducted in 1991, integrated a group feeding alternative (Arctic T) with the individual packaged rations (MRE and LLRP). The test was conducted during 10 consecutive days at Fort Greely, AK with 96 soldiers of the 5/11th FA Bn of the 6ID(L). Both batteries received an Arctic T (T) ration for the breakfast and dinner meals, while the lunch meal consisted of an MRE for one group (T/MRE/T) and an LLRP for the other (T/LLRP/T). Mean energy intake was similar between groups (3271 and 3035 kcal/day for the T/MRE/T and T/LLRP/T groups, respectively) meeting about 70 percent of MRDA and 77 percent of energy expenditure. Mean intake of protein, vitamins and minerals was adequate except for the T/LLRP/T group's vitamin B_6 (58 percent of MRDA). Neither group was dehydrated (SG=1.020 to

1.025) thus hydration status was not a significant factor in food intake. Body weight loss (1.1 and 0.6 percent, respectively) was significant ($p \leq 0.05$) within, but similar between, groups. This weight loss was primarily from body fat with total body fat stores decreasing 10.6 and 4.9 percent, respectively. Mean nitrogen balance was +0.30 g indicating that the energy deficit was not exerting a severe metabolic stress. Although the psychophysiological data indicate that both groups were stressed by the change from garrison to cold weather field operations, the decrease over time in negative symptoms and moods indicates that neither group was severely stressed by the field exercise and that the rations provided were sufficient to sustain them. Even though the LLRP received higher ratings than the MRE, the amount consumed of the two rations was similar. The higher ratings given the LLRP could have been caused by a "halo effect" of the new novel ration. In the Arctic T Ration, 60% of the breakfast items and 65% of the dinner items received hedonic ratings of 6 (like slightly) or better. Subjects preferred receiving items which were supposed to be heated when served warm or hot as opposed to when served cool or cold.It was concluded that the feeding modality chosen for Cold Weather Field Feeding should depend upon environmental conditions, mission parameters, and water availability.

2. USARIEM is the lead laboratory for medical testing of new and improved operational rations for effects on nutritional status, health, and performance. In 1991, USARIEM tested the New Generation Survival Ration (NGSR) and the Meal, Ready-to-Eat (MRE) version XII. USARIEM also assisted the Soldier Science Directorate (SSD) of U.S. Army Natick Research, Development and Engineering Center to test the new Tray Pack Ration (T Ration) items and Soldier Enhancement Program MRE items.

a. The NGSR was designed to replace the 1961 General Purpose Survival Packet (GP). Its test was done in June 1991 at the U.S. Air Force Combat Survival School, Fairchild Air Force Base, WA with 98 volunteers (87 males and 11 females). The NGSR group received three rations plus supplemental foods, and the GP group received four rations plus supplemental foods totalling approximately 930 kcal/day/group for the 5-day study period. Subjects were also allowed to forage for additional

food. Water was plentiful but required purification. Mean hours of inactivity for the groups were similar, averaging 6.3 hours/day. Total daily energy expenditure was approximately 4700 kcal/day. Mean daily energy intakes of the two rations were significantly different: 774 kcal/day for the NGSR group and 635 kcal/day for the GP group. Mean protein and carbohydrate intakes values were similar but fat intake was significantly higher for the NGSR group. Mean body weight (BW) losses in both groups were significant but did not differ between groups: 2.9 kg (3.8% BW) for the NGSR and 3.4 kg (4.5% BW) for the GP groups. There were no significant differences in psychomotor performance between groups. Mean fluid intakes were comparable for both groups: 4.3 L/day for the NGSR group and 4.5 L/day for the GP group. The post- study urine specific gravity, blood chemistry and water turnover data showed that subjects were adequately hydrated. Both groups had small to moderate ketonemia post-study, consistent with caloric restriction. Both rations received acceptable ratings. The variety of textures and tastes the NGSR bar proved to be a positive aspect of the new ration, and should be maintained, however. Because its diuretic effect, coffee should be replaced by soup or some other hot or cold beverage powder.

b. USARIEM assisted the SSD in conducting two concurrent 7-day studies at Pohakaloa Training Area, HI in June/July 1991 with four companies of male soldiers from the 1/21st Infantry Bn, 25ID(L). One study assessed the consumption and acceptance of new T Ration menu items, the second, the consumption and acceptance of new Soldier Enhancement Program (SEP) MRE items in place of the current MRE items. For each study, one company (the test group) was fed the new food items (T Rations or SEP MRE's, respectively) and another company (the control group) was fed items currently approved in the food supply system. Subjects in the T Ration study were fed T Rations for breakfast and supper, and an MRE for lunch. Subjects in the MRE study were fed 3 MREs per day. No foods other than those issued as part of the study were allowed. Military Nutrition Division personnel collected and analyzed daily urine samples on subsets of 40 soldiers from each group to assess hydration, and assisted in collecting daily food consumption, daily body weights, and daily and end-of-study acceptability data. A complete

evaluation of hydration status results is being prepared for the SSD technical report on this study.

c. Current OTSG policy (AR 40-25) dictates that the MRE should only be fed for 10 consecutive days. The policy was based on weight loss results of studies conducted on initial versions of the MRE in 1983 and 1985. Improvements to the MRE have increased nutrient intakes and lessened the magnitude of the weight loss, but questions remain as to the effects of long-term consumption on the health and performance of the soldier. The Chief of Staff of the Army provided guidance resulting in an Office of The Surgeon General tasking to provide specific data to be used to evaluate the feasibility of altering the 10-day MRE feeding policy in AR 40-25. Thus, a study of soldiers consuming the MRE XII during a 30-day field training exercise was conducted in October, 1991 at Fort Chaffee, AR, with 67 male soldiers of the 902d Engineer Company from Fort Leonard Wood, MO. The objective of the study was to provide data on the impact of consuming solely MREs for 30 consecutive days in a field environment on the nutritional status, body composition, and performance of soldiers. Thirty-five soldiers (test group) received 3 MREs per day while the other 32 soldiers (control group) received two A Ration meals and one MRE per day. No outside food or beverages were permitted in either group. Daily food/fluid consumption, urine samples, and body weights were collected. In addition, body composition measures (whole-body x-ray scanning procedure (DEXA) and circumferences), blood samples, and 48-hour urine samples were obtained at the beginning, mid-point, and end of the study. Physical and psychomotor performance (road march and neurophysiological symptoms checklist) measurements were made at the beginning and end of the study. A final acceptability questionnaire was administered at the completion of the study. Data are currently being analyzed.

3. In response to a request from the Commander, Ranger Training Brigade, a biochemical and immunological assessment of nutritional status was conducted during Ranger Class 91-11 (23 August - 1 October 1991). Recent Ranger classes had experienced attrition rates of 50 to 60 percent and an unusually high incidence of streptococcal infections. Self-reported weight loss by Ranger Trainees completing the course

averaged about 15 percent of body weight. The specific goal of this study was to determine the effect of Ranger training on nutritional status, muscle mass, bone density, muscle strength, and selected indices of immune function. Data were collected at five points: 1) pre-course baseline data, 2) end of Benning training phase, 3) end of mountain phase, 4) end of jungle/swamp phase, and 5) end of desert phase. Attrition rate was 82.6 percent from 190 soldiers who began the training. Most trainees lost more than 10 percent of their initial body weight (median = 15.6 percent loss), indicating a substantial caloric deficit during training. The energy deficit was made up primarily from fat stores; more than half of the soldiers used up 90 percent or more of their available fat stores (median = 90.4 percent loss). Lean body mass was highly protected in most soldiers (median = 6.5 percent loss). Serum indices of energy and nitrogen metabolism support this observation for the first two phases of training, but suggest a shift to increased protein catabolism in the last two phases. There was no measurable reduction in bone density. Maximal grip strength and grip holding time did not change between beginning and end. Incremental dynamic lift capacity declined significantly ($p \leq 0.01$) between beginning and end, with the soldiers who lost the most fat-free mass having the largest decrements. The reduced T- and B-lymphocyte proliferation in response to PHA and PWM challenges indicates that immune protection to infectious diseases was reduced, especially after the mountain and jungle phases. The nearly absent Interleukin-6 (IL-6) production after the jungle phase indicates a reduced ability of cells to recruit assistance in controlling inflammation (cellulitis) and infection. Biochemical markers of nutritional status did not show a clear defined nutrient deficiency, suggesting that the MRE provides adequate amounts of key vitamins and other nutrients in this otherwise energy deficient diet. Results of this study have been briefed to the Commander, Ranger Training Brigade and peer-reviewed by the Committee on Military Nutrition. A follow-up study utilizing a higher plane of nutrition is planned for summer, 1992.

4. In response to a request by the Commandant, U.S. Marine Corps (USMC), the Military Nutrition Division developed and pilot tested a sports nutrition program for training environments which demand a high level of physical

performance. The program consists of two major components: (1) nutritional menu standards for menu planning and suggested menu modifications with recipe ideas for a "training table" and (2) nutrition education with an emphasis on sports nutrition principles.

a. Baseline data for program planning and evaluation were collected at the Officer Candidates School (OCS) of the Marine Corps Combat Development Command (MCCDC), Quantico, VA, in August 1990. Analyses of menu data, dietary intake data, and nutritional knowledge test data were completed in CY91. The MCCDC 30-day master menu provided an average of 7033 kcal/day (53, 14, and 35 percent of calories from carbohydrate, protein, and fat, respectively). The OCS menu was lower in calories (5517 kcal/day) than the master menu. Based on percent of calories, the OCS 5-day menu was lower in carbohydrate and higher in fat (49 and 39 percent, respectively) than the MCCDC master menu, the Military Recommended Dietary Allowance (MRDA; 50-55 percent carbohydrate, ≤ 35 percent fat) or the sports nutrition guidelines (60-70 percent carbohydrate, 25-30 percent fat). Both menus were high in saturated fat (14 percent of calories)and the sodium, (2189 mg/1000 kcal and 2152 mg/1000 kcal for the MCCDC master menu and OCS menu, respectively). The OCS students' (n=121) mean energy intake was 4423 kcal/day, with a macronutrient distribution of 50.5, 14 and 35 percent of total calories for carbohydrate, protein, and fat, respectively. The mean cholesterol (693 mg/day) and saturated fat (13 percent of total calories) intakes were higher than national nutrition guidelines of ≤ 300 mg/day and ≤ 10 percent of total calories, respectively. Absolute mean micronutrient intakes met or exceeded the MRDAs, but nutrient density guidelines were not met by greater than 90 percent of the OCS students for vitamin B_6, folate, magnesium, potassium, and zinc. The dietary intake and menu analyses results indicate that OCS students would benefit from both menu modification and nutrition education designed to decrease fat, saturated fat, and cholesterol intakes and increase the consumption of nutrient dense, complex carbohydrates. Results of the nutrition knowledge test also indicate a need for nutrition education. The average score of OCS students on the sports nutrition knowledge test was 51 percent correct.

b. A feasibility test of a low-fat training table menu was conducted at the USMC OCS in August 1991. The 5-day test menu provided 7400 kcal/day, with a macronutrient distribution of 65 percent carbohydrate, 13 percent protein, and 25 percent fat. Analyses of the dietary intakes, sports nutrition knowledge questionnaire, diet history, hydration status and body weight changes of 162 OCS students subsisting on the training table menu is underway. Although the training table menu was well received by the candidates, issues of added cost, availability, and the labor intensity of fat-reduced food items menu need to be addressed before the implementation of a training table menu could be considered on a wide-scale basis.

c. The nutritional knowledge and food frequency questionnaires were also administered separately to approximately 250 Marine Corps. Results of these questionnaires will be compared to those of the OCS population to assist in planning over-all the education program.

5. The Military Nutrition Division participated in the Occupational Medicine Division's study of neuromuscular and metabolic adaptations to eccentric exercise. The purpose of this study was to examine some of the neuromuscular and metabolic adaptions to eccentric exercise and the usefulness of several biochemical markers associated with muscle and connective tissue damage. In order to use several of these markers (3-methylhistidine, hydroxyproline, and hydroxylysine), the dietary sources of these amino acids had to be controlled. Military Nutrition Division developed 6-day rotating menu free of animal muscle protein and gelatin and they prepared and recorded daily intake of all foods. The mean daily intakes for eight subjects over the 16-day study period were 3544 kcal, with a macronutrient distribution of 55, 11, and 34 percent for carbohydrate, protein and fat, respectively. The Occupational Medicine Division is currently analyzing the resulting biochemical data.

PUBLICATIONS:

1. Edwards, J.S.A., E.W. Askew, N. King, C.S. Fulco, R.W. Hoyt, and J.P. DeLany. An assessment of the nutritional intake and energy expenditure of unacclimatized U.S. Army soldiers living and working at high altitude. USARIEM Technical Report No. T/10-91, June 1991.

2. Edwards, J.S.A., and D.E. Roberts. The influence of a high calorie supplement on the consumption of the Meal, Ready-to-Eat in a cold environment. Mil. Med. 156:466-471, 1991.

3. Jones. T.E., R.W. Hoyt, R. Schwartz, D.A. Schoeller, E.W. Askew, A. Cymerman. Energy and water balance of soldiers during a strenuous cold weather field training exercise at moderate altitude. Interagency Committee on Human Nutrition Research, Fifth Conference for Federally Supported Human Nutrition Research, Bethesda, MD, February 20, 1991.

4. King, N. USARIEM Studies Soldiers at High Altitude. USAMRDC News, July 1991.

5. King, N., T.W. Odom, H.W. Sampson, S.L. Pardue. In Ovo administration of boron alters bone mineralization of the chicken embryo. Biological Trace Element Research. 30:47, 1991.

6. King, N., T.W. Odom, H.W. Sampson, A.G. Yersin. The effect of in ovo boron supplementation on bone mineralization of the vitamin D-deficient chicken embryo. Biological Trace Element Research. (In Press).

7. Rose, M.S., R. Moore, R. Mahnke, E. Christensen, and E.W. Askew. Weight reduction techniques used when weight standards are enforced. USARIEM Technical Report No. pending.

8. Rose, M.S., P.C. Szlyk, R.P. Francesconi, L.S. Lester, and R. Whang. Acceptability and effect of carbohydrate-electrolyte solutions on electrolyte homeostasis during field training. Mil. Med. 156:494-501, 1991.

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ABSTRACTS:

9. Baker-Fulco, C.J., R.W. Hoyt, T.E. Jones, and E.W. Askew. Voluntary consumption of a carbohydrate (CHO) supplement by soldiers during a winter climb on Mt. Rainier. FASEB J. 5:A1128, 1991.

10. Edwards, J.S.A., N. King, C.S. Fulco, and E.W. Askew. Food intake and acceptability of unacclimatized U.S. soldiers living and working at altitude. FASEB J. 5:A1666, 1991.

11. Jones, T.E., R.W. Hoyt, J. Hnilcka, D.A. Schoeller, R.B. Schoene, E.W. Askew, and A. Cymerman. Deuterium oxide (^2H_2O) measurement of water intake during a winter climb on Mt Rainier. FASEB J. 5:A1127, 1991.

12. King, N., T.W. Odom, H.W. Sampson, and A. Yersin. In ovo boron administration alters bone mineralization of the vitamin D-deficient chicken embryo. FASEB J. 5:A1309, 1991.

13. Moore, R.J., J.F. Patton, E.W. Askew, and R.P. Mello. Effects of dietary carbohydrate intake on perceptual responses to prolonged load-carriage exercise. FASEB J. 5:A2657, 1991.

14. Thomas, C.D., J.C. Peters, G.W. Reed, N.N. Abumrad, and J.O. Hill. Effect of diet composition on nutrient balance. Inter. J. Obesity. 15(supplement 3):E9, 1991.

PRESENTATIONS:

15. COL Eldon W. Askew. Nutrition for a Cold Environment at the Winter Wilderness Medical Society, Crested Butte, CO, 12-15 February 1991.

16. COL Eldon W. Askew. Energy Balances of U.S. Soldiers Consuming a 2000 kcal Calorie Lightweight Ration for 30 Days, Commonwealth Defence Science Organization Conference, Auckland, New Zealand, 18-22 February 1991.

17. COL Eldon W. Askew. Nutrient requirements for work in a Cold Environment, at USARIEM Environmental Medicine Course, Natick, MA, 19 May 1991.

18. COL Eldon W. Askew. Carbohydrate Supplement for Work at High Altitude:Liquid vs Solid Food Supplements, at First World Congress on Wilderness Medicine, Whistler, British Columbia, Canada, 13-18 July 1991.

19. COL Eldon W. Askew. Invited seminar on Nutritional Assessment of U.S. Soldiers Rapidly Deployed to the Andean Altiplano, Bolivia, at Tripler Army Medical Center, Honolulu, HI, 25 February 1991.

20. LTC Nancy King. Current research at USARIEM at AMSC Nutrition Postgraduate Course, Washington, DC, 15-19 April 1991.

21. LTC Nancy King. In ovo boron administration alters bone mineralization of the vitamin D-deficient chicken-embryo, at AMSC Research Course, Silver Spring, MD, 15 August 1991.

22. LTC Nancy King. Research at USARIEM at AMSC Research Course, Silver Spring, MD, 15 August 1991.

23. LTC Nancy King. Nutrition Issues Unique to Women in the Military, at National Academy of Science Symposium, Washington, DC, 11 December 1991.

24. Tanya E. Jones. Energy and water balance in soldiers during a strenuous cold weather field training exercise at moderate altitude, at Fifth Conference for Federally Supported Human Nutrition Research Units and Centers, Bethesda, MD, 20-21 February 1991.

25. CPT Robert J. Moore. USARIEM research on sodium requirements in the heat, at Committee on Military Nutrition workshop on Nutrition for Work in Hot Environments, Washington, DC, 11-12 April 1991.

26. CPT Robert J. Moore. Observations on soldier food intake practices in Saudi Arabia, at Committee on Military Nutrition workshop on Nutrition for Work in Hot Environments, Washington, DC, 11-12 April 1991.

27. CPT Robert J. Moore. Military nutrition findings in the areas of cold weather feeding, requirements for carbohydrate

supplementation at altitude, and sodium requirements for heat acclimation at Worldwide Troop Subsistence Conference, Richmond, VA, 25 October 1991.

28. MAJ Cecilia D. Thomas. Substrate oxidation study results at Vanderbilt University Metabolic Nutrition Research Center, Nashville, TN, 29-31 May 1991.

KEY BRIEFINGS:

29. COL Eldon W. Askew and LTC Nancy King. Site visit liaison for Cold Weather Field Feeding study (HURC #433) to 6ID (Light) staff, Fort Wainwright, Fairbanks, AK, 3 January 1991.

30. COL Eldon W. Askew, LTC Nancy King, MAJ Cecilia D. Thomas, CPT Robert J. Moore, Doris E. Sherman, Carol J. Baker-Fulco, Tanya E. Jones, and Deborah A. Jezior. Commanders Briefing, Natick, MA, 4 March 1991. Military Nutrition Research program to USARIEM Commander, Natick, MA, 4 March 1991.

31. COL Eldon W. Askew, LTC Nancy King, MAJ Cecilia D. Thomas, CPT Robert J. Moore, Doris E. Sherman, Carol J. Baker-Fulco, and Tanya E. Jones. Military Nutrition Research Program to COL Karen E. Fridlund, Natick, MA, 26 March 1991.

32. COL Eldon W. Askew, CPT Robert J. Moore, Carol J. Baker-Fulco, and Tanya Jones. Military Nutrition Research Program to MAJ Fiedel Castro, TRADOC System Manager - Soldier (Sustainment), Natick, MA, 3 May 1991.

33. COL Eldon W. Askew. Military Nutrition Research briefing to MG Richard Travis, Commander, USAMRDC, Natick, MA, 10 July 1991.

34. COL Eldon W. Askew. USARIEM Military Nutrition Research briefing to BG(P) Smith, Director, Transportation, Energy and Troop Support, DCSCOG, Natick, MA, 29 October 1991.

35. Carol J. Baker-Fulco. Military Nutrition Research Program to WRAIR Fellows, Natick, MA, 15 February 1991.

36. Carol J. Baker-Fulco. Performance Nutrition Intervention Project to the DOD Food and Nutrition Research and Engineering Board, Natick, MA, 7 May 1991.

37. Carol J. Baker-Fulco. Findings and impressions from Quantico Performance Nutrition Intervention study to Marine Corps Foodservice Officers Conference, New Orleans, LA, 27 August 1991.

38. Carol J. Baker-Fulco. Military Nutrition Division Research Program to WRAIR Fellows, Natick, MA, 19 September 1991.

39. Tanya E. Jones. The New Generation Survival Ration (NGSR) to 3636th Combat Crew Training Wing, Fairchild Air Force Base, WA, 7 March 1991.

40. Tanya E. Jones. The Long Life Ration Packet to U.S. Army Engineer Center Sapper Leader School personnel, Fort Leonard Wood, MO, 3 Apr 91.

41. LTC Nancy King. Cold weather field feeding study to BG David Mead, ADC-S 6th ID, Fort Greely, AK, 29 January 1991.

42. LTC Nancy King, MAJ Cecilia D. Thomas, CPT Robert J. Moore, and Tanya E. Jones. Military Nutrition Division Research program to CPT Ann Andersen, Nutrition Staff Officer and Class I Food Service Advisor, 5th Corps, USAEUR, Natick, MA, 28 May 1991.

43. LTC Nancy King. Military Nutrition Research Program to BG Richard G. Larson, Director, Transportation, Energy and Troop Support, DCSLOG, Natick, MA, 18 July 1991.

44. LTC Nancy King. Military Nutrition Research briefing to COL John W. Kolmer, Military Assistant for Medical and Life Sciences, Office of the Under Secretary of Defense for Acquisition/Research and Advanced Technology, Natick, MA, 12 September 1991.

45. LTC Nancy King. Military Nutrition Research as it relates to the ration development process to CAPT (USN)

Richard Tuggle, Commander, Subsistence, and COL Charles Lalli, Chief, Supply Division, Subsistence, Defense Personnel Support Center, Natick, MA, 2 December 1991.

46. MAJ Cecilia D. Thomas. Effects of long-term subsistence on operational rations to Mr. Hernandez and members of Office of Emergency Operations, White House Military Office, at Natick, MA, 10 December 1991.

SIGNIFICANT TDY:

COL Eldon W. Askew and CPT Robert J. Moore. Liaison visit to Ranger Training Brigade on proposed nutritional assessment of Ranger Class #11, Fort Benning, GA, 4-7 May 1991.

COL Eldon W. Askew. Site visit to Louisiana State University to review Grant progress, 30-31 May 1991.

COL Eldon W. Askew and CPT Robert J. Moore. Site visit liaison for proposed 30-day MRE study. Fort Chaffee, AR, 11 June 1991.

COL Eldon W. Askew and CPT Robert J. Moore. Site visit to Ranger School to coordinate upcoming assessment study of Ranger trainees. Fort Benning, GA. 6-8 May 1991.

COL Eldon W. Askew and MAJ Cecilia D. Thomas. Committee on Military Nutrition Research, Review of Louisiana State University Grant, Pennington Biomedical Research Center, Baton Rouge, LA, 18 September 1991.

Carol J. Baker-Fulco, Principal Investigator, and a study team of 20, to evaluate training table menu for Performance Nutrition Intervention Project, Marine Corps Combat Development Command, Quantico, VA, 2-21 August 1991.

Tanya E. Jones and David E. Caretti. Site visit liaison preliminary to New Generation Survival Ration (NGSR)/General Purpose Survival Packet (GP) field evaluation. Fairchild Air Force Base, WA, 7-8 March 1991.

Tanya E. Jones, Principal Investigator, and a study team of nine to assess the nutrition and hydration status of aircrew members consuming either the New Generation Survival Ration (NGSR) or General Purpose Survival Packet (GP) during a simulated survival situation. U.S. Air Force Survival School, Fairchild Air Force Base, Spokane, WA,
15 June-2 July 1991.

Tanya E. Jones. Meal, Ready-To-Eat, Forum II, Fort Lee, VA, 24-26 September 1991.

LTC Nancy King, Principal Investigator and a study team of 20 to conduct Cold Weather Field Feeding Study, at Fort Greely, AK, 22 January-8 February 1991.

CPT Robert J. Moore. To participate in epidemiological and medical evaluations of combat soldiers in a desert environment. Walter Reed Army Institute of Research, Washington, DC, January 1991.

CPT Robert J. Moore. Special Mission to Saudi Arabia on duty with Surgeon, Aviation Brigade, 101st Airborne Division (AA): provide on-site evaluation and advice on sleep logistics, duty cycles, and performance of flight and ground crews during Operation Desert Storm. January-March 1991.

CPT Robert J. Moore. Principal Investigator on field study to assess a Ranger School class from a nutritional and physiological standpoint: Coordinated data collection at three environmental locations in Georgia, Florida, and Texas, 23 August-2 October 1991.

Doris E. Sherman. Sixteenth National Nutrient Databank Conference. San Francisco, CA, 16-19 June 1991.

MAJ Cecilia D. Thomas. Army Nutrition Planning Committee Meeting. AAFES Headquarters, Dallas, TX, 19-20 March 1991.

MAJ Cecilia D. Thomas. Army Nutrition Planning Committee, OTSG, Office of Chief Dietitian. Falls Church, VA, 18-19 June 1991.

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MAJ Cecilia D. Thomas, Elaine Christensen, Brooke Cheema, and members of U.S. Army Natick RD&E Center Soldier Science Directorate. Field study on Improved Tray Rations and Soldier Enhancement Program MREs. Pohakaloa Training Area, Hawaii, 23 June-3 July 1991.

MAJ Cecilia D. Thomas. Advance Planning Briefing for 30-day MRE Study. U.S. Army Combat Systems Test Activity, Aberdeen Proving Ground, MD, 14 August 1991.

MAJ Cecilia D. Thomas. Operational Test Readiness Review for 30-Day MRE Study. Headquarters Test and Experimentation Command, Fort Hood, TX, 27-29 August 1991.

MAJ Cecilia D. Thomas and MAJ Barry Fairbrother. On-site liaison visit for 30-Day MRE Study to 902d Engineer Company of U.S. Army Engineer School, Fort Leonard Wood, MO, 4 September 1991.

MAJ Cecilia D. Thomas and MAJ Barry Fairbrother. On-site liaison visit for 30-Day MRE Study. Fort Chaffee, AR, 5 September 1991.

MAJ Cecilia D. Thomas. Site visit to discuss progress of Menu Modification project. Louisiana State University, Baton Rouge, LA, 19 September 1991.

MAJ Cecilia D. Thomas, Principal Investigator, and a study team of 22 to conduct 30-Day MRE Study, Fort Chaffee, AR, 30 September-6 November 1991.

MAJ Cecilia D. Thomas. Army Nutrition Planning Committee. OTSG, Falls Church, VA, 3 December 1991.

Doris E. Sherman. University of Texas, U.S. Department of Agriculture, and Human Nutrition Information Service workshop and conference on "Nutrition Monitoring." Bethesda, MD, 6-8 November 1991.

SIGNIFICANT VISITORS:

COL Karen E. Fridlund, Chief, Dietitian Section, Army Medical Specialist Corps, OTSG, Washington, DC, 25-27 March 1991.

CPT Ann Andersen, Nutrition Staff Officer and Class I Food Service Advisor, 5th Corps, 28 May 1991.

SFC Kenneth Klippel, First Sergeant, 902d Engineer Company, advance planning for 30-Day MRE study, 15 August 1991.

Catherine Champagne, Ph.D., Dietitian in Charge of Extended Table of Nutrient Values, Pennington Biomedical Research Institute, Louisiana State University, Baton Rouge, LA, 23 September 1991.

Ellen Brooks, Exercise Physiologist in Charge of the Physical Fitness Facility, Pennington Biomedical Research Institute, Louisiana State University, Baton Rouge, LA, 23 September 1991.

George Bray, M.D., Director, Pennington Biomedical Research Center, Louisiana State University, Baton Rouge, LA, 6 November 1991.

PROFESSIONAL APPOINTMENTS/ACTIVITIES:

Askew, Eldon, W., Ph.D. COL, MS, Division Chief. DoD representative to the Interagency Committee for Federally Funded Human Nutrition Research; U.S. representative to the Food Science and Preventive Medicine Groups of the Commonwealth Defence Research Organization; Army Liaison to NAS Food and Nutrition Board Committee on Military Nutrition Research; member, Nutrition Advisory Panel, United States Olympic Committee invited faculty speaker at the Winter Wilderness Medical Society Meeting, Crested Butte, CO; invited journal reviewer of Journal of Applied Physiology, Journal of Nutrition, American Journal of Clinical Nutrition, Physician and Sportsmedicine, and Journal of the American Dietetic Association.

King, Nancy, Ph.D., LTC, SP. Invited speaker and participant in National Academy of Sciences forum on "Nutrition, Women and Their Health," Washington, D.C.

Thomas, Cecilia D., M.Ed., MAJ, SP. USARIEM representative to Department of the Army Nutrition Planning Committee.

Moore, Robert J., Ph.D., CPT, MS. Awarded U.S. Army Southwest Asia Campaign Ribbon; Invited participant and speaker at the National Academy of Sciences Committee on Military Nutrition Research Workshop "Nutrition for a Hot Environment"; invited speaker and participant in the DCSLOG World-Wide Nutrition Conference, Fort Lee, VA.

Sherman, Doris E., M.S., Research Investigator. Beta Test Reviewer, University of Texas Nutrient Analysis Program.
Baker-Fulco, Carol J., B.S., Research Investigator. Invited speaker at U.S. Marine Corps Annual Foodservice Conference, New Orleans, LA.

Jones, Tanya E., M.S., Research Investigator. Invited speaker at the 5th Conference for Federally Supported Human Nutrition Research Units and Centers, Bethesda, MD.

MILITARY PERFORMANCE & NEUROSCIENCE DIVISION

SIGNIFICANT RESEARCH FINDINGS/DEVELOPMENTS:

1. Several new technologies were developed to assess changes in brain function associated with exposure to stress. One such technology, *in situ* hybridization of messenger RNA, a technique based on recent molecular biology advances, was employed to monitor changes in expression of specific genes in the brain that are associated with exposure to various stressors. Increased levels of hypothalamic vasopressin mRNA were observed in acutely stressed animals. In addition, baseline levels of the mRNA of the stress-related neuromodulator corticotropin releasing factor were assessed.

Another technical advance combines in vivo microdialysis and high performance liquid chromatography to assess brain norepinephrine. This neurotransmitter is only present in minuscule quantities in the brain but is critical for the regulation of the response of organisms to stressors. The necessary techniques have been developed to allow continuous assessment of changes in norepinephrine in unrestrained animals.

2. A study was conducted to examine the effects of a new class of drugs, muscarinic-type 2 receptor blockers, on brain acetylcholine release. It was found that the drug methoctramine significantly increased brain acetylcholine release when the technique of in vivo microdialysis was used to measure extracellular acetylcholine concentration. The effects that were observed in rat hippocampus were substantial and dose related. Drugs that enhance the release of acetylcholine may prevent decrements in learning and memory associated with exposure to environmental stressors.

3. A study was conducted to assess the effects of hypobaric hypoxia on brain function and behavior of rats. In addition, several drugs and nutrients that may protect against the adverse behavioral and physiological consequences of acute exposure to this stressor were assessed. Decrements in learning and memory were observed in animals exposed to altitudes of 5,944 and 6,401 meters but not 4,572 or 5,486 meters. At 5,486 meters there was a significant decrease in brain acetylcholine release as measured by the technique of in vivo microdialysis which permits direct assessment of extracellular neurotransmitter release. When the drug nimodipine, a calcium channel blocker, was administered to animals during exposure to hypoxia (5,846 meters), it was found to restore brain acetylcholine levels to baseline levels. To determine whether exposure to hypobaric hypoxia produces structural damage in the brain, animals were exposed to hypobaric hypoxia for four days and their brains were examined using histochemical and conventional histological techniques. At 5,486 meters only minor structural and histochemical changes were observed.

4. When people travel to terrestrial altitudes greater than 3,000 meters, their physiological and psychological well-being

are usually compromised. These altitudes can also affect the outcome of military operations at high altitude, e.g., capturing an observation post at high altitude is likely to be heavily determined by medical factors such as high-altitude sickness and work limitations. Such phenomena are reviewed in the Handbook of Military Psychology in a chapter entitled, "Effects of high terrestrial altitude on military performance." This chapter describes various physiological and psychological limitations associated with high altitude and strategies used to decrease them. Careful and expert application of strategies such as optimal ascent profiles, medications, psychological strategies, and nutrients can facilitate coping and functioning in high-altitude environments.

5. The following visual functions were studied during extended exposure to hypoxia over a 12-day period on the summit of Pikes Peak, Colorado: Optical vergence - An index of the natural fixation distance adopted by each eye in the absence of a visual stimulus. This position normally is the intermediate point between the limits of near focus and infinity, and is usually referred to as the physiological resting position of vergence. Acuity - Ability to resolve fine visual detail, as differing from normal resolution of 1 arc-minute at moderate illumination (10 foot-lamberts). Phoria - The state of ocular muscle balance of the two eyes, usually specified as a type of deviant turning of the optic axis away from the mid-line of sight (eso-, exo- hyper-, hypo, incyclo- excyclo- phoria, and generically heterophoria, respectively). Peripheral contours of the visual field - The outermost limits of visual detection for red, green, and white stimuli, as measured by visual perimetry. Available data concerning hypoxic effects on these aspects of visual function are based only on relatively short exposures of up to 4 hours. In order to obtain data involving longer exposure periods, measurements on all of the above tests were first obtained at sea level for baseline comparison purposes, and then at 2-day intervals following arrival at altitude (4,300 meters) over the entire 12-day period. Analysis of the results indicated no impairment of any of the measures; rather, there were indications of a slight improvement in performance on all tests over the period of altitude exposure. By comparison with data obtained in previous short-term studies (up to 4

hours exposure) in which significant decrements were found, it would seem that the effects of altitude on those aspects of visual function are most likely to occur very early and are of brief duration. These findings could have significant meaning for military operations involving speed and surprise, in which personnel may not yet show signs of acute mountain sickness but could still be impaired in their ability to perform visual tasks.

6. An assessment was made of the side-effects of the potent steroid, dexamethasone, on cognitive performance and affect in a high altitude study where dexamethasone was used as a prophylactic drug for acute mountain sickness. Cognitive performance was evaluated with 5 tasks, and affect was measured with the Clyde Mood Scale and the Multiple Affect Adjective Check List. Sixteen soldiers received either dexamethasone (4 mg every 6 hours) or placebo before and after ascent to 4,300 meters. On the first day at altitude, subjects treated with dexamethasone correctly performed more computer interaction and addition problems than did subjects treated with placebo. Treated subjects were also less sleepy, depressed, and anxious. No adverse effects were noted when dexamethasone was discontinued on Day 3 at altitude. These results indicate that dexamethasone, at altitude, positively influences cognitive performance and mood states.

7. Ascents above 4,000 meters can cause acute mountain sickness (AMS) and adversely affect symptoms, moods, and performance. It is assumed that individuals afflicted with AMS will be even more susceptible to changes in the other parameters; however, previous studies have suggested that the time courses are different. The relationships between symptoms, moods, and performance and a measure of altitude sickness, the AMS-cerebral (AMS-C) factor of the Environmental Symptoms Questionnaire (ESQ), were therefore investigated. Twenty male soldiers were evaluated on 11 symptom, 13 mood, and 14 cognitive/motor performance measures after exposure to altitudes of 550 and 4,700 meters for 5-7 hours and a difference score (between altitudes) was calculated for each measure. The difference scores for 70% of the symptom, 46.2% of the mood, and 28.6% of the performance measures were significantly correlated with the AMS-C difference score. The difference scores for each measure were then rank-ordered (to

standardize for differences across measures) and the sum of the ranks was calculated separately for each subject's symptoms, moods, and performance. The AMS-C factor score was found to correlate significantly with these composite scores (r_s = 0.90, 0.77, and 0.59 for symptoms, moods, and performance, measures respectively). Changes in AMS after 5-7 hours at 4,700 meters correlated best with changes in symptoms, then moods, and finally performance. This suggests that these parameters may have different responses over time during the initial 5-7 hours at altitude.

8. Military operations throughout history have been compromised as much by exposure of personnel to extreme weather conditions as by actual battle casualties. Heat and cold exposure can also significantly impair the performance of military personnel while they are still operational. A review of research on this topic was published as a chapter in the Handbook of Military Psychology. The chapter discusses the basic human thermoregulatory mechanisms involved in adjustment to heat and cold exposure, reviews the published literature on effects of severe heat and cold conditions on human behavior, assesses major human factors problems related to military equipment and clothing when used under hot and cold conditions, and makes practical recommendations for performing military activities under severe climatic extremes.

9. The laboratory research of others which indicated that single doses of oral contraceptives (OCs) and caffeine affect the ability to discriminate colors was validated. This was done in a nonlaboratory setting by surveying habitual use of OCs and caffeine by 43 female college students and relating that information to their performance on the Farnsworth-Munsell 100-Hue Test. Higher caffeine consumption among OC users was related to poorer color discrimination in the yellow through blue segment of the color spectrum, whereas, among non-users of OCs, it was related to better performance. Study design limitations do not permit attribution of causation to either caffeine or OCs.

10. Successful sentry duty performance requires that the soldier maintain both (a) sufficient attention to detect the infrequent appearance of visual targets and (b) accurate rifle marksmanship skills. While sustained attention (vigilance)

has been shown to be impaired by length of time on duty, rifle marksmanship has been shown to be influenced by the encumbrance of combat clothing. A study was conducted to evaluate the separate and combined effects of the administration of a standard 200 mg dose of caffeine (an over-the-counter stimulant commonly used to maintain mental alertness, equivalent to about 2 cups of coffee) and the wearing of the standard M17 protective mask with hood (standard combat chemical protective headgear) on the speed of detection of visually presented targets and rifle marksmanship during three hours of simulated sentry duty. Twelve male subjects wore the battle dress uniform (BDU), helmet, web gear, and full canteen. In accordance with a 2 x 2 (drug x headgear) repeated measures experimental design, each subject was administered four separate test conditions: (a) placebo without M17 mask, (b) 200 mg caffeine without M17 mask, (c) placebo with M17 mask, and (d) 200 mg caffeine with M17 mask. During each three-hour test session, the subject assumed a standing foxhole position and monitored the target scene of the Weaponeer Rifle Marksmanship Simulator. When a pop-up target appeared, the subject lifted his rifle, aimed, and fired at the target. Speed of target detection and rifle marksmanship were each averaged every 30 minutes for analysis. The results indicated that speed of target detection deteriorated with time on the task, that caffeine improved sentry duty performance by attenuating the vigilance decrement curve, and that wearing the M17 protective mask impaired sentry duty performance by decreasing the ability to hit targets.

11. In a double-blind, cross-over design study, 24 highly trained male soldier volunteers were administered moderate doses of caffeine (200 mg), diphenhydramine (25 mg), or a placebo on three separate days prior to performing a 2-hour visual vigilance task. Caffeine significantly enhanced performance of the task and diphenhydramine caused significant decrements.

12. In collaborative study with the Division of Experimental Therapeutics of the US Army Walter Reed Army Institute of Research, data were collected to evaluate the side effects of mefloquine, the drug of choice for the prophylaxis and treatment of chloroquine-resistant strains of malaria. There

is a growing literature on adverse reactions to mefloquine, with approximately 5% of those using the drug for malaria prophylaxis experiencing difficulties. Adverse side effects range from mild (e.g., sleep disturbance, fatigue, dizziness, poor concentration, headache) to severe (e.g., depression, confusion, anxiety, seizures, delirium, coma). The study population included 378 military volunteers over a 13 week time period. The side effects of mefloquine were measured by survey techniques, the monitoring of medical treatment facilities, and an objective field measure of activity/sleep (the Actigraph). The Military Performance and Neuroscience Division, USARIEM, coordinated the administration of standardized questionnaires to assess symptomatology (USARIEM Environmental Symptom Questionnaire, ESQ), and psychological moods (Profile of Mood States, POMS).

13. Demographic information with "mark-sense" questionnaires was collected during the P^2NBC^2 Detailed Equipment and Detailed Operations Test. Military performance data were also analyzed to identify characteristics of soldiers who did not complete one or more of the daily test trials because they were "pulled" (withdrawn from a trial). Several findings suggest significant implications for training, readiness, and combat effectiveness. These soldiers were characterized by great variability, youth, modest active duty time, and meager experience with chemical defense and sustained operations exercises. Life style and logistical factors also made functioning in MOPP more difficult. Almost half of the soldiers acknowledged that they were smokers and half who required prescription lenses did not have corrective inserts for their chemical protective masks. Demographic variables such as the soldier's age, rank, physical test scores, time on active duty, and marital status were predictive of some aspects of military performance during this field study, i.e. the younger, lower-ranking soldier, who has less than 2 years of active duty, was more likely to end his participation in this demanding field exercise. Also, soldiers who were "pulled" were more likely to initiate actions which resulted in their being "pulled" again; they also performed for shorter durations each time they were "pulled". Such trends suggest self-initiated "pulls" became the major reason for withdrawal from a trial as the study progressed. Fortunately, many of these trends can be countered to produce substantial gains in

the fighting force, if they are recognized and managed correctly.

14. Self-rated measures of symptoms and moods are especially sensitive to stressors and often detect changes in well-being before more objective indices. To exploit such measurement properties, a 40-item Subjective States Questionnaire (SSQ) was developed to obtain estimates of a soldier's capacity (or the effort required) to perform military tasks and common activities, relevant to junior enlisted soldiers. SSQ data were collected during six, 135-minute test sessions in a laboratory study of heat stress conducted with the Navy Clothing and Textile Research Facility (Natick, MA). Nine soldiers gave verbal ratings of "how they felt at that moment" during selected exercise, rest, and recovery intervals. On most items, well-being and performance capabilities were sensitive to such manipulations. Furthermore, statistically significant differences in the stressfulness of some uniform ensembles were demonstrated on some of the ESQ and SSQ items. Recovery was rapid after termination of an exercise-heat exposure.

15. An experiment was designed to determine if two frequently-used weight training protocols differentially affect mood state in novice lifters, possibly also influencing adherence to training programs. Mood states of nine males and nine females were examined before and after six different weightlifting workouts, which varied according to inter-set rest interval (one versus three minutes), total work (low versus high), and weight lifted (light for 10 repetitions per set versus heavy for five repetitions per set). The Profile of Mood States was given two minutes pre-, and at two minutes, two hours, 24 hours and 48 hours post-workout. Stronger negative moods including tension, depression and fatigue resulted from higher work, lower weight with higher repetitions per set and shorter inter-set rest periods. With the lower weight, higher total-work routine, the one-minute rest period produced more tension and depression than the three-minute routine. For the heavier weight, lower total-work routine, three minutes of rest produced more tension and depression than did one minute, possibly because of impatience brought on by the longer rest periods when fatigue was minimal. For novice lifters, lower total work type routine

with an inter-set rest period of three minutes is likely to produce relatively high rates of compliance and low attrition.

16. Evaluating the soldier's well-being and ability to function in the chemical protective ensemble is difficult since such phenomena involve complex and interacting subsystems, e.g. the soldier, mission, and weather. To address these issues, a Division researcher organized and chaired a symposium, "Consequences of Wearing the Chemical Protective Ensemble: Illustrative Assessment Approaches," for the meeting of the Military Testing Association in San Antonio, Texas. Participants, from varied organizations and several scientific disciplines, included psychologists, a biophysicist, a chemical engineer and two physicians. They described findings from laboratory and field studies, simulations, and computer modeling. The symposium demonstrated the usefulness of various assessment methodologies for evaluating adverse effects which result from wearing the chemical protective combat clothing. A potential outcome of the symposium would be development of a charter to bring together experts from several scientific disciplines periodically to review progress towards quantifying such adverse effects. The proceedings of this symposium are being published as a USARIEM technical report.

17. A draft manuscript from the Institute for Defense Analyses (Alexandria, Virginia) entitled "The Effects of Wearing Protective Chemical Warfare Combat Clothing on Human Performance" was reviewed. This manuscript critically described the extensive range of operational and experimental studies that are concerned with the effects of wearing chemical warfare protective combat clothing on individual and unit performance. The reviewer pointed out that the performances under consideration must be specified since performance is not a generic construct; this issue was incorporated into the final manuscript.

18. A Division psychologist reviewed a coordinating draft of FM 22-51, Leader's Manual for Combat Stress Control, which will be published in 1992. This manual describes the complex characteristics, context, and exceptional challenges of modern warfare. It also prescribes thoughtful holistic strategies which should increase the fighting capabilities of the soldier

and minimize combat stress. FM 22-51 evolved from an earlier draft of FM 8-51, Combat Stress Control in a Theater of Operations, which was reviewed by USARIEM psychologists in 1990.

19. The Division Chief was assigned to Operation Desert Storm, Persian Gulf, January to March 1991. As part of an interdisciplinary USAMRDC research team, she was assigned to the Office of the BDE Surgeon, HHC - 101st AVN BDE, 101st Airborne Division. On assignment she conducted research in the field to identify the relationship of sleep and nutritional factors to physiological and cognitive indices of combat performance. Preliminary findings of this effort were reported to various groups, including the DoD Human Factors Engineering Technical Group and the Eighth NATO Stress Workshop.

PUBLICATIONS:

1. Banderet, L.E. (Symposium Chairman). Consequences of wearing the chemical protective ensemble: Illustrative Assessment Approaches. Proceedings of the Military Testing Association. (In Press).

2. Banderet, L.E. Varied Approaches for assessing the effects of the chemical protective ensemble. Paper in the Symposium: Consequences of wearing the chemical protective ensemble: Illustrative Assessment Approaches. Proceedings of the Military Testing Association, (In Press).

3. Banderet, L.E. and R.L. Burse. Effects of high terrestrial altitude on military performance. In: Handbook of Military Psychology. R. Gal and D. Mangelsdorff (Eds.). Wiley, New York, 1991, pp. 233-254.

4. Banderet, L.E. and R.L. Burse. Effects of high terrestrial altitude on military performance. USARIEM Technical Report No. T2-92, (In Press).

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6. Fine, B.J. Comment on Highes, P.K. and Vingrys, A.J. Reduced contrast sensitivity when viewing through an aircraft windscreen. (Letter). Aviat. Space Environ. Med. 62:1108, 1991.

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PRESENTATIONS:

28. Banderet, L.E. Varied approaches for assessing the effects of the chemical protective ensemble. Presentation in the Symposium: Consequences of wearing the chemical protective ensemble: Illustrative Assessment Approaches (L.E. Banderet, Chairman). Military Testing Association, San Antonio, TX, October 1991.

29. Johnson, R.F. Rifle firing simulation: effects of MOPP, heat, and medications on marksmanship. Military Testing Association, San Antonio, TX, October 1991.

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31. Lieberman, H.R. Neuroscience Strategies to Enhance Performance. USAARL Scientific Seminar, Ft. Rucker, AL, April 1991.

32. Lieberman, H.R. Caffeine Consumption: risks and benefits. American Psychological Association, San Francisco, CA, August 1991.

33. Lieberman, H.R. Human Activity Monitoring Technology. Children's Hospital, Harvard Medical School, Boston, MA, September 1991.

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35. Lieberman, H.R. Assessment of Human Patterns of Activity and Circadian Rhythms. VA Medical Center, Minneapolis, MN, December 1991.

36. Mays, M.Z. Environmental stress during Operation Desert Storm. DoD Human Factors Engineering Technical Group. Natick, MA, May 1991.

37. Mays, M.Z. Operation Desert Shield/Desert Storm Lessons Learned. Current Concepts in Environmental Medicine Course. US Army Research Institute of Environmental Medicine, Natick, MA, May 1991.

38. Mays, M.Z. Mental Performance and Environmental Extremes. Current Concepts in Environmental Medicine Course. US Army Research Institute of Environmental Medicine, Natick, MA, May 1991.

39. Mays, M.Z. Environmental stress during Operation Desert Storm. Eighth NATO Stress Workshop. San Antonio, TX, September 1991.

KEY BRIEFINGS:

40. Richard F. Johnson, Ph.D. Techniques and pitfalls in symptom assessment: The ESQ and other rating scales.

Occupational Health and Performance Directorate Seminar Series, US Army Research Institute of Environmental Medicine, Natick, MA, February 1991.

41. John L. Kobrick, Ph.D. History and development of the Environmental Symptoms Questionnaire. Occupational Health and Performance Directorate Seminar Series, US Army Research Institute of Environmental Medicine, Natick, MA, February 1991.

42. MAJ Mary Z. Mays, Ph.D. Research on nutrition and soldier performance. Briefing presented to BG Richard G. Larsen, Director, Transportation, Energy, and Troop Support, DCSLOG. US Army Research Institute of Environmental Medicine, Natick, MA, 1991.

43. MAJ Mary Z. Mays, Ph.D. Military Performance and Neuroscience Division: Research and Analysis. Briefing presented to MG Richard T. Travis, Commander, USAMRDC. US Army Research Institute of Environmental Medicine, Natick, MA, 1991.

SIGNIFICANT TDY:

Louis E. Banderet, Ph.D. Working Group Meeting for the P^2NBC^2 Detailed Equipment and Detailed Operations Test. Aberdeen Proving Ground, Aberdeen, MD, March 1991.

Louis E. Banderet, Ph.D. Site visit, Department of Neurology, Georgetown University Hospital, Washington, DC, June 1991.

Louis E. Banderet, Ph.D. OBC Vehicle Identification Training (Classroom and Field Segments), Fort Knox, KY, June 1991.

Richard F. Johnson, Ph.D. Site visit to Kaneohe Marine Corps Air Station, Hawaii, to conduct field study on the side effects of mefloquine; conducted in collaboration with Division of Experimental Therapeutics, WRAIR, 24 August-7 September 1991.

Harris R. Lieberman, Ph.D. Participate in Medical Defense Bioscience Review, Aberdeen, Maryland, August 1991.

Harris R. Lieberman, Ph.D. Participate in National Academy of Medicine, Food and Nutrition Board's Committee on Military Nutrition for review of Pennington Biomedical Research Center Army sponsored research program, Baton Rouge, LA, September 1991.

MAJ Mary Z. Mays, Ph.D. TDY to Operation Desert Storm, Persian Gulf, to identify relationship of sleep and nutritional factors to physiological and cognitive indices of combat performance. January-March 1991.

MAJ Mary Z. Mays, Ph.D. TDY to the Pentagon to serve as Technology Staff Officer, Office of the Assistant Surgeon General for Research and Development, Liaison to the Office of the Secretary of the Army for Research, Development and Acquisition. October-December 1991.

SIGNIFICANT VISITORS:

Dr. Carlos Comperatore, Visiting Scientist, USAARL, July 1991.

Dr. Tamar Kadar, Visiting Scientist, Israel Institute of Biological Research, November 1991.

Dr. Aharon Levy, Visiting Scientist, Israel Institute of Biological Research, November 1991.

PROFESSIONAL APPOINTMENTS/ACTIVITIES:

Mays, Mary Z., Ph.D., MAJ, MS, Division Chief. Awarded U.S. Army Surgeon General 9B skill designator and U.S. Army Southwest Asia Campaign Ribbon. Chair, Symposium on "Caffeine and Human Behavior," Annual meeting of the American Psychological Association, San Francisco, August 1991. Member, Technical and Scientific Advisory Group for the P^2NBC^2 Program; Heat Stress Master Plan Working Group; Soldier Capability and Performance Technical Working Group. Technology Staff Officer, Office of the U.S. Army Assistant Surgeon General for Research and Development.

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Johnson, Richard F., Ph.D., Research Psychologist. Interim Division Chief. Senior Lecturer in Psychology, Northeastern University, Boston, MA. Editorial Consultant, Psychosomatic Medicine, Journal of Aging and Health. Member, USARIEM Quality Assurance Committee. President-Elect (Jul 90 - Jun 91) and President (Jul 91 - Jun 92), Natick Chapter of Sigma Xi, The Scientific Research Society.

Banderet, Louis E., Ph.D., Research Psychologist. Senior Lecturer in Psychology, Northeastern University, Boston, MA. Judge, Massachusetts Science Fair, MIT, Cambridge, MA. Reviewer, Aviation, Space and Environmental Medicine.

Fine, Bernard J., Ph.D., Research Psychologist. Adjunct Professor of Psychology, Boston University Graduate School. Reviewer, Psychological Reports, Perceptual and Motor Skills.

Kobrick, John L., Ph.D., Research Psychologist. Senior Lecturer in Psychology, Northeastern University, Boston, MA. Reviewer, Aviation, Space and Environmental Medicine, Military Psychology, Perceptual and Motor Skills.

Lieberman, Harris, R., Ph.D., Research Psychologist. Member, National Institute of Mental Health (NIMH) Peer Review Panel for the Small Business Innovative Research Program. Reviewer, Office of Technology Assessment (OTA), Congress of the United States. Consultant, US Air Force Office of Scientific Research Visiting Scientist, Department of Brain and Cognitive Sciences, Massachusetts Institute of Technology. Secretary, Natick Chapter of Sigma Xi, the Scientific Research Society. Reviewer: Physiology and Behavior, Brain Research Bulletin, Psychopharmacology, Journal of Neural Transmission, Military Psychology.

OCCUPATIONAL MEDICINE DIVISION

SIGNIFICANT RESEARCH FINDINGS/DEVELOPMENTS:

1. During road marches light infantry units commonly carry very heavy loads over extended distances. Historical accounts suggest that this type of marching can result in a variety of specific medical problems; however, there have been few systematic investigations of acute injuries associated with such activity. We studied march-related injuries in 335 infantry soldiers who performed a maximal effort 20 km road march while carrying a 46 kg total load. Soldiers had not performed road marching in at least 2 months because of snow cover in the training areas. Passive surveillance was conducted by recording requests for medical care during the march and by following soldiers for 12 days post-march by recording march-related injuries seen in the Troop Medical Clinic. Active surveillance was conducted at the end of the march by examining the soldiers' feet for specific medical problems. Twenty-four percent of the soldiers suffered one or more injuries resulting in 44 days of limited duty. The most common injuries seen in the passive surveillance were blisters (35 cases), back strains and back pain (21 cases) and metatarsalgia (11 cases). Active surveillance revealed that blisters, "hot spots" and contusions occurred on the feet of 69%, 60%, and 22%, respectively, of all soldiers. These data indicate that units without recent road march training can expect a high incidence of injuries as a result of a single demanding road march.

2. Both military and sports medicine professionals have a long-standing interest in identifying risk factors for injuries associated with intense physical activity and training. Injuries to females are of particular concern because of their increased participation in both military operations and civilian sports programs. It has long been assumed that specific strength or flexibility imbalances may be associated with injuries. These imbalances may manifest as (a) differences in strength or flexibility in muscle groups on the right and left side of the body or (b) a low strength ratio between an agonistic muscle group and its antagonist. Over a 3 year period we performed an extensive preseason

screening for strength and flexibility in a group of female athletes. Each season after the screening we recording all injuries that occurred to these athletes. We found that athletes with a hamstring muscle group that was 15% weaker on one side of the body were 2.6 times more likely to suffer lower extremity than athletes without this imbalance ($p=0.04$). Also, subjects that had a 15% greater flexibility in the hip extensor on one side of the body were 2.6 times more likely to suffer lower extremity injuries than athletes without this imbalance ($p<0.001$). These data demonstrate that specific strength and flexibility imbalance were associated with lower extremity injuries in females.

3. We have previously demonstrated male basic trainees with higher levels of aerobic fitness and muscle strength were less likely to get injured during the 8 week basic training cycle. In order to see if these relationships extended in military occupational training we studied 298 male soldiers in a light infantry battalion in Alaska. Injuries over the last six months were recorded by a 100% review of the soldiers' medical records. Physical fitness was measured using Army Physical Fitness Tests (APFT) scores. Fifty-one percent of the soldiers suffered one or more injuries. Soldiers were divided into quartiles based on their scores on each of the 3 APFT scores. The quartile of soldiers with the slowest two-mile run times were 1.5 times more likely to get injured than the quartile of soldiers with the fastest run time ($p=0.09$). The quartile of soldiers with the least number of sit-ups were 1.6 times more likely to get injured than the quartile of soldiers with the largest number of sit-ups ($p=0.03$). These data suggest an association between physical fitness and the incidence of injuries in light infantry soldiers.

4. When an individual performs exercise to which he is not accustomed, muscle soreness often occurs and can limit the performance of that individual. Muscle soreness has been shown to be associated with structural damage to the muscle tissue. This damage includes hemorrhage, inflammation and disruption of the normal arrangement of actin and myosin filaments. The inflammatory processes involve macrophage infiltration followed by removal of necrotic muscle fibers. After a few days, there is evidence of muscle regeneration as evidenced by the presence of satellite cells, myotubules and

new sarcoplasma. Magnetic Resonance Imaging (MRI) is a new technology that shows promise as a non-invasive method of detecting and possibly quantifying exercise-induced muscle damage. Magnetic Resonance Spectroscopy (MRS) may also be capable of quantifying ratios of inorganic phosphate to phosphocreatine which may serve as a marker for exercise induced muscle damage. The Massachusetts Institute of Technology Francis Bitter National Magnet Laboratory has MRI and MRS capability reserved for research purposes. We have completed a Cooperative Research and Development Agreement (CRDA) with this Laboratory to develop this new technology. Thus far we have been successful in producing images of exercise induced damage and have begun construction of coils for the study of inorganic phosphates.

5. Studies of illnesses and injuries performed to date by this division have focused largely on enlisted soldiers in basic training and in light infantry units with an average age of 21 years. To expand our database we studied medical problems in a group of senior military officers (LTC and COL) attending the Army War College during the 1991 Academic Year (N=216). Medical problems were obtained from a 100% screening of the officers medical records. Officers average time in service was 21 years and their average age was 43 years. Eleven percent of all officers (N=24) had prior knee surgery and 1% (N=3) had prior back surgery. Injuries accounted for 38% of the total medical incidence with musculoskeletal pain, sprains/strains and abrasions/lacerations accounting for 31%, 23% and 11%, respectively, of the total injury incidence. Illnesses accounted for 62% of the total medical incidence with infections (mainly upper respiratory infections) accounting for 50% of the illness incidence. Medical incidence were also followed prospectively during the 10 month period while the officers were at the AWC. During this time, injury incidence was 2.4% per month and most injuries appeared to be sports related. Injuries accounted for 42% of the total medical incidence with strains/sprains, musculoskeletal pain, abrasions/lacerations and fractures accounting for 26%, 17%, 16% and 7%, respectively of the total injury incidence. Illnesses accounted for 58% of the total medical incidence with infections (mainly upper respiratory infection) accounting for 46% of the illness incidence.

6. In epidemiological studies involving very large numbers of subjects it is not always practical or possible to test the physical fitness of all participants. One alternative to direct testing may be the use of simple questionnaires. If, through the use of a questionnaire, individuals are able to categorize their fitness level relative to others of their age and gender, this may provide a useful tool for evaluating relationships between fitness components and disease and injury. We conducted a study to compare self-ratings of various components of physical fitness with objective measures of physical fitness. These comparisons were made in two groups of male infantry soldiers (N=96 and 222) and one group of older male military officers (N=241). To obtain self-ratings of physical fitness subjects were asked "Compared to others of your age and sex how would you rate your... a) endurance, b) sprint speed, c) strength, d) flexibility." Subjects responded to each of the 4 questions on a 5 point scale. Self-ratings of endurance were systematically related to three measures of aerobic capacity (r=0.29 to 0.53). Self-ratings of sprint speed showed only weak relationships with measures of anaerobic capacity (r=0.10 to 0.17). Strength ratings were systematically related to measures of maximal strength (r=0.28 to 0.53). Upper body strength measures were more closely associated with the self-ratings of strength than were measures of lower body strength. Responses to the flexibility question were systematically related to measures of hip/low back flexibility (r=0.30 and 0.48) but not to other measures of flexibility. It appears that physically active subjects are able to approximately classify their aerobic capacity, muscle strength and some types of flexibility.

7. A study was conducted on 42 soldiers of 10th Special Forces group assigned to a company at Ft. Devens, MA to determine the incidence and risk factors of injuries and illnesses resulting from special operational training. A retrospective 100% medical records review was conducted and recent APFT scores were also obtained. Over the observed period, 6.8% suffered one or more lower extremity training injuries. The most common injuries were injuries that involved the foot, ankle and knee. The slowest third of soldiers in the 2 mile run were at a greater risk of injury than the fastest third group (75.0%/22.2%, p=.09). Soldiers doing the fewest pushups were also at a greater risk of injury

then those performing the most. These data suggest that a large percentage of injuries in a highly trained unit are lower extremity overuse injuries. Also, soldiers that are physically the fittest are at a lower risk for injury during this highly specialized training.

8. Data analysis has been completed on prospective data on 180 light infantry soldiers (cohorts) collected at Ft. Drum, NY from 1989-90. The incidence of training injuries was 10.0% per month, which was similar to rates reported in other light infantry units. The majority of the injuries were overuse type and predominantly involved the lower extremities. Specific risk factors for injury were also identified. Among non-cadre members, we saw a clear association of low fitness levels (slow 2 mile run, high BMI, high %body fat) with higher risk of injury. Smokers were also found to be at a significantly greater risk for injury when compared with non-smokers ($p=.01$).

9. Developing preventive strategies to reduce or prevent musculoskeletal injuries related to military training is a very important aspect of our injury research program. We have just completed an experimental study at the Institute that examined whether topical drying agents (i.e. antiperspirants) reduced the incidence of foot blisters in soldiers marching with a load (46lbs) over 12 miles in a warm environment. Other outcome measures included incidence of contact dermatitis, skin bacterial colony counts and foot temperature changes. Data analysis has not been completed.

10. Smoking cigarettes has consistently been associated with higher risk of musculoskeletal injuries in studies of both Army trainees and infantry soldiers. At Ft. Bliss in 1989, the risks for those trainees smoking no cigarettes prior to entering the Army vs those smoking 1 to 10 per day and those smoking over 10 per day were 17%, 20% and 22%, respectively (p for trend< 0.05). At Ft. Benning in 1987, the risks for trainees who did not smoke before the onset of IET vs those who smoked 1 to 10 cigarettes before the Army, and those who smoked more than 20 were 29%, vs 36% vs 50%, respectively (p for trend $<.05$). Among infantry soldiers at Ft. Drum the trend was 19% for non-smokers, 34% for those smoking 1 to 10 cigarettes per day, 37% for 11-20 per day and 50% for those

smoking 20 more per day (p for trend <.005). Smoking holds up as a risk factor even in multivariate models that control for physical fitness. This data suggests that smoking cessation may not only contribute to the long term health of soldiers, but also to a reduction of the short term risk of training injuries among vigorously active Army troops.

PUBLICATIONS:

1. Jones, B.H. and W.O. Roberts. Medical management of endurance events: Incidence, prevention and care of casualties. Chapter 28 In: Guidelines for the Team Physician. Cantu, R. (Ed.). American College of Sports Medicine, Lea & Febiger, Philadelphia, pp. 266-286, 1991.

2. Knapik, J.J., C. Meredith, B. Jones, R. Fielding, V. Young, and W. Evans. Leucine metabolism during fasting and exercise. Journal of Applied Physiology. 70:43-47, 1991.

3. Knapik, J.J., C. Bauman, B. Jones, J. Harris, and L. Vaughan. Preseason strength and flexibility imbalances associated with athletic injuries in female collegiate athletes. American Journal of Sports Medicine. 19:76-81, 1991.

4. Knapik, J, J. Staab, M. Bahrke, K. Reynolds, J. Vogel, and J. O'Connor. Soldier performance and mood states following a strenuous road march. Military Medicine. 156:197-200, 1991.

5. Knapik, J, K. Reynolds, J. Staab, J.A. Vogel, and B. Jones. Injuries associated with strenuous road marching. Military Medicine. (In Press).

ABSTRACTS:

6. Knapik, J.J, K. Reynolds, K. Ang, J. Staab, and B. Jones. Association of physical fitness and training injuries in light infantry soldiers. Medicine and Science in Sports and Exercise. 23:S39, 1991.

7. Reynolds K., J. Pollard, J. Cunero, J. Knapik, and B. Jones. Frequency of training and past injuries as risk factors for injuries in light infantry soldiers. Medicine and Science in Sports and Exercise. 23: S:4, 1991.

PRESENTATIONS:

8. Jones, B.H. Epidemiology of injuries in Army and other military populations. Army Preventive Medicine Conference. Falls Church, VA, 25 September 1991.

9. Jones, B.H. Musculoskeletal training-related injuries: Facts and fiction. Current Concepts in Environmental Medicine. USARIEM, Natick, MA, 16 May 1991.

10. Jones, B.H. Military training-related injuries. Advanced Course in Military Fitness. Army War College, Carlisle Barracks, PA, 8 March 1991.

11. Jones, B.H. Medical threats to Operations Desert Storm. Open Lecture. Army War College, Carlisle Barracks, PA, 8 March 1991.

12. Jones, B.H. Nature of the medical threat to Operation Desert Storm. Grand Rounds, Cutler Army Community Hospital, Ft. Devens, MA, 25 January 1991.

13. Knapik, J.J. Physiological aspects of backpacking. Presented as part of the Symposium on Backpacking for Work and Recreation. New England Chapter, American College of Sports Medicine Annual Meeting. Marlborough, MA, 7-8 November 1991.

14. Reynolds K. Musculoskeletal injuries in military operations and training. AMEDD Professional Short Course: Current Concepts in Environmental Medicine. USARIEM, Natick, MA, 15 May 1991.

15. Reynolds K., Pollard, J., Cunero, J., Knapik J., Jones, B. Frequency of training and past injuries as risk factors for injuries in infantry soldiers. American College of Sports Medicine. Orlando, FL, 17 May 1991.

16. Reynolds K. Symposium: "Backpacking Injuries in Work and Recreation". American College of Sports Medicine (New England Chapter). Worcester, MA, 7-8 November 1991.

KEY BRIEFINGS:

17. Bruce H. Jones, M.D., LTC, MC. Background and Concept for a Tri-Service Workshop on Injury Surveillance and Prevention. Armed Forces Epidemiology Board, Parson's Island, MD, 12 October 1991.

18. Bruce H. Jones, M.D., LTC, MC. Concept for a Tri-Service Workshop on Injury Surveillance and Prevention. To: Dr. Mazuki and others, OASD (HA), Pentagon, Washington, D.C., 18 September 1991.

19. Bruce H. Jones, M.D., LTC, MC. Background and Concept for a Tri-Service Workshop on Injury Surveillance and Prevention. To: Dr. Lempke, OASD (Environment), Pentagon, Washington, D.C., 18 September 1991.

20. Bruce H. Jones, M.D., LTC, MC. Background and Concept for a Tri-Service Workshop on Injury Surveillance and Prevention. To: COL Peak, COL Ertdmann, COL Tomlinson, CAPT Parsons, and others, OTSG, Falls Church, VA, 6 September 1991.

21. Joseph Knapik, Sc.D., CPT, MS. Epidemiology of Injuries and Illnesses in senior military officers. To: Staff of U.S. Army Physical Fitness Research Institute and Command Group of Dunham Army Health Clinic, Carlisle Barracks, PA, August, 1991.

22. Katy L. Reynolds, M.D., LTC, MC. Progress report on study regarding injury rates and potential predictors of injury associated with physical training among light infantry units with different training programs. To: Col. Prentice Thompson (Hospital Commander, Silas B. Hays Community Hosp.), LTC Wilson (5th Bn Commander, 21st Infantry Regiment), LTC Swanneck (2nd Bn Commander, 9th Infantry Regiment), LTC McCaffery (Division Surgeon, 7th Med.), LTC Phillip (Chief of Prev. Med.); Ft Ord, CA, June 1991.

23. Katy L. Reynolds, M.D., LTC, MC. To: LTC Fuller, Executive Officer, 10th Special Forces; MAJ McDermott, 10th Special Forces Group Surgeon. Study of the 10th Special Forces Group to determine injury/illness rates and patterns and potential predictors of injury associated with physical training in the 10th Special Forces, Ft Devens, MA, August 1991.

SIGNIFICANT TDY:

Joseph Knapik, CPT, and staff of one. Conduct field study to obtain data on epidemiology of injuries and illnesses in senior military officers. Army War College, Carlisle Barracks, PA, August-September 1991.

PROFESSIONAL APPOINTMENTS/ACTIVITIES:

Jones, Bruce H., M.D., LTC, MC, Division Chief. Appointed Department of Defense Representative, CDC Advisory Committee for Injury Prevention and Control for the U.S. Department of Health and Human Services. Reviewer, Physician and Sports Medicine. Abstracts reviewer, American College of Sports Medicine Annual Meeting 1992.

Knapik, Joseph, Sc.D., MAJ, MS, Research Physiologist. Reviewer, Medicine and Science in Sports and Exercise, and Journal of Applied Sports Science Research. Member of the Scientific Review Committee, USARIEM and member, Army War College Science Advisory Committee.

Reynolds, Katy L., M.D., LTC, MC, Research Medical Officer. Member, Medical Surveillance and Risk Management Committee, Credentials Committee, and Alternate member, Human Use Review Committee, USARIEM.

OCCUPATIONAL PHYSIOLOGY DIVISION

SIGNIFICANT RESEARCH FINDINGS/DEVELOPMENTS:

1. Litter-bearing is a physically demanding task in which muscular fatigue may be readily induced. It was hypothesized that use of a harness would improve litter-bearing performance and decrease post-performance decrements that could interfere with the soldiers ability to treat and defend his patient. Use of a harness was assessed for two stretcher-carrying tasks: (1) carrying and loading as many patients as possible within 15 minutes and (2) carrying a litter for as long as possible, up to a half hour. These tasks were simulated using a motor-driven treadmill and each carry technique was tested for two and four-person teams. During repeated short carries, harness use slowed four-person teams because of the time needed to attach the harness to the litter handles and possibly because of the swinging motion of the suspended harness. This slowing may have contributed to the expenditure of less physical exertion, as measured by heart rate, for men/women and two/four person teams. The results reveal that harness use for four-man teams does not yield significant benefit. Women, however, benefitted from harness use in both two- and four-person teams and both genders perceived less exertion when using a harness in two-person teams. During the prolonged carry, subjects carried the stretcher longer with a harness than without (two-person teams: 3.02 versus 21.93 min; four-person teams: 9.51 versus 24.75 min). When using the harness, heart rate and oxygen uptake were lower for both team sizes. Less litter movement occurred with two-person teams, while more movement occurred with four-person teams; and fine motor coordination was better after the litter-carry. The results demonstrate that a harness system improves the performance of both men and women while carrying a litter, especially for an extended period of time.

2. In order to ascertain the effectiveness and ease of use of two types of harness systems in a field environment, soldiers carried and loaded as many litter patients as possible in 15 minutes. Three carrying conditions were used for four-person teams: 1) no harness, 2) an H-cross design harness with aluminum "J-hooks" to secure the litter handles

(HX-hook), and 3) an H-design with loops to secure the litter handles (H-loop). The first two conditions were also used to investigate two-person teams. The HX-hook design was ranked as the preferred carrying method for both two-person ($p < 0.0001$) and four-person teams ($p < 0.03$). For the four-person carry, oxygen uptake was lowest with the modified H-cross design ($p < 0.05$); subjects used a smaller percent of their VO_2 max ($p < 0.01$); post-carry fine-motor performance was quicker ($p < 0.01$), as measured by a cord and cylinder fine-motor coordination task; and subjects rated the design as easiest to use ($p < 0.02$). Time to adjust the harness prior to each lift was slowest and fewer carries were completed with the H-loop design harness. In a four-person team, men and women completed more carries without a harness. As a two-person team, women completed more carries with a HX-harness. Vertical movement of the stretcher was monitored by attaching an activity monitor to the patients wrist to assess patient comfort. Less movement was detected with the modified H-cross design harness. During a structured interview, women indicated a need for a harness in a combat situation, while men qualified their reply as being situation-dependent. The results indicate the H-cross design is superior to the H-loop design and that a harness is useful for female two-person teams during repeated short carries.

3. The effects of team size and gender variations on maximum dead-lifting performance was examined for groups of three persons. Three men, three women, two men plus one women, and two women plus one man teams were studied. The team lifting strength averaged 16% less than the sum of the individual lifting strengths. In gender groupings, the difference between the team lifting strength and the sum of the individual members' strength was 8.9% less for three women, 15% less for three men, 17.3% less for two men and one woman, and 25.6% less for two women and one man. Using the three men team lift as the maximum possible (405.9 ± 30.2 kg), two men plus one woman lifted 80% as much (377.2 ± 31.7), two women plus one man lifted 71% as much (297.7 ± 34.7), and three women lifted 60% (235.8 ± 15.1) as much as three men. The data for groups of two and four person lifting teams are currently being collected.

4. Biomechanical analysis of load carriage. An experiment was conducted in which 16 male subjects carried backpacks of 6, 20, 33, and 47 kg while walking at 1.1, 1.3 and 1.5 meters/sec. They were filmed at 60 frames/sec using a Locam 16 mm camera. Three trials per condition yielded 36 trials per subject. Electronically transduced information was fed into a computer 500-1,000 times per second. The forces and torques exerted on the ground by the subjects' feet were monitored using a force platform. Muscle electrical activity in shoulder, back and leg muscles was monitored using self-amplified electrodes. Backpack motion was monitored using a tri-axial accelerometer. Walking speed was paced using an in-house designed and fabricated locomotion speed cuing device. Several computer programs were written in-house to collect, integrate, and analyze the information. Much of the electronically collected data has already been analyzed and numerous effects of walking speed and load have been revealed. A labor-intensive film analysis was begun but will require more time for completion.

5. Skill-training feedback experiment. Various electrical malfunctions have delayed the start of experimentation on a system developed in-house to train motor skill through the use of computerized augmented feedback. The system includes a cycle ergometer fitted with transducers to measure forces on the pedals and position of the pedals and crank, as well as a computer program which calculates and displays non-productive forces on a computer screen, which the test subjects will attempt to minimize. Considerable effort has been made to resolve the electrical problems so that testing can begin to assess whether efficiency can be improved through feedback training and at what rate such skill degrades upon cessation of training.

6. Body fat standards for Army women were found to be overly stringent for the desired goals and should be liberalized by +2% body fat in each of the four age groups. The DCSPER approved this recommendation, along with appropriate changes in the accession standards to better match the retention standards.

7. A new four-compartment model of body composition, based on Army data from 1959, was proposed and tested for

reliability. It is currently being evaluated as the criterion measure for body composition in studies reexamining field expedient measurement methods across different ethnic and body size groups.

8. Insulin concentrations when fasted were found to be a key predictor of HDL-cholesterol in young men and women, based on data collected from 200 non-smoking, highly fit men and women at West Point. This finding is independent of body composition and may reflect nutrient intakes. This hypothesis is currently under investigation.

PUBLICATIONS:

1. Harman, E.A. The measurement of human mechanical power. In: Physiological assessment of human fitness. P.J. Maud and C. Foster (Eds.), Champaign, IL: Human Kinetics, (In Press).

2. Harman, E.A. The biomechanics of resistance exercise. In: Essentials of strength training and conditioning. T.R. Baechle (Ed.), Lincoln, NE: National Strength and Conditioning Association, (In Press).

3. Harman, E. Body size/composition and biomechanical aspects of task performance. In: Proceedings of the National Academy of Sciences - Institute of Medicine - Food and Nutrition Board - Workshop on Body Composition and Military Performance. Washington, D.C. (In Press).

4. Harman, E.A., M. Johnson, and P.N. Frykman . A movement-oriented approach to exercise prescription. National Strength and Conditioning Association Journal (In Press).

5. Harman, E.A., and P.N. Frykman. The multiple mini-circuit weight training program. National Strength and Conditioning Association Journal (In Press).

6. Harman, E.A., M.T. Rosenstein, P.N. Frykman, R.M. Rosenstein and W.J. Kraemer. Estimation of human power output from maximal vertical jump and body mass. Journal of Applied Sport Science Research 5:116-120, 1991.

7. Harman, E. The importance of testing power output. National Strength and Conditioning Association Journal 13:72-72, 1991.

8. Harman, E., M. Rosenstein, P. Frykman, and R. Rosenstein. Transforming research into practice: The effects of arms and countermovement on vertical jumping. National Strength and Conditioning Association Journal 13:38-39, 1991.

9. Rice, V. J. A usability assessment of two harnesses for stretcher-carrying. In Advances in Industrial Ergonomics & Safety IV. Kumar, S. (Ed.) (In Press).

10. Rice, V. J. Human factors engineering/ergonomics and rehabilitation. Rehabilitation Management (In Press).

11. Rice, V. J. Complex cognitive performance and antihistamine use: Executive summary. US Army Aeromedical Research Laboratory Technical Report No. CR91-1, 1991.

12. Rice, V. J. Making soldiers out of citizens. Advance for Occupational Therapists 7:12, 1991.

13. Rice, V. J. Letter to the editor, Some thoughts on cumulative trauma. Advance for Occupational Therapists 7:4, 1991.

14. Sharp, M.A. and J.A. Vogel. Maximal lifting strength in military personnel. In Advances in Industrial Ergonomics and Safety IV. Kumar, S. (Ed.) (In Press).

15. Williamson, T. L., and V.J. Rice. Re-evaluation of the caldwell regimen: The effect of instruction on hand-grip in men and women. In Advances in Industrial Ergonomics and Safety IV. Kumar, S. (Ed.) (In Press).

ABSTRACTS:

16. Friedl, K.E. and J.A. Vogel. Looking for a few good generalized body fat equations. American Journal of Clinical Nutrition 53:795-796, 1991.

17. Harman, E., R. Rosenstein, and P. Frykman. A new augmented feedback system for improvement of cycling efficiency. Journal of Biomechanics 24:263, 1991.

18. Marchitelli L.J. and K.E. Friedl. Fasted serum insulin is a key determinant of HDL-cholesterol in fit young men and women. The Physiologist 34:248, 1991.

PRESENTATIONS:

19. Friedl, K.E. Sources of error in underwater weighing. Fifth Conference for Federally Supported Human Nutrition Research Units and Centers, National Institutes of Health. Bethesda, MD, 20 February 1991.

20. Harman, E. Biomechanical aspects of backpacking. American College of Sports Medicine, New England Annual Meeting, Westboro, MA, 6-7 November 1991.

21. Harman, E. A movement oriented approach to exercise prescription. National Strength and Conditioning Association Annual Meeting, St. Louis MO, 19-22 June 1991.

22. Rice, V. J. The Americans with Disabilities Act: Reasonable Worksite Accommodations. National Disability Management Conference & Exhibit: Washington Business Group on Health/Institute for Rehabilitation and Disability Management, Washington, D.C., October, 1991.

23. Rice, V. J. and M. Sharp. Effects of a shoulder harness on stretcher-carrying performance. Human Factors Society 35th Annual Meeting, San Francisco, CA, September, 1991.

24. Rice, V. J. Occupational assessment of MOS job classifications in the Army. Walter Reed Army Medical Center Industrial Rehabilitation and Work Hardening Seminar, August, 1991.

25. Rice, V. J. Performance and mood effects of two antihistamines. Army Medical Specialist Corps Research Course, Washington, D.C., August, 1991.

26. Rice, V. J. Research opportunities at USARIEM. Army Medical Specialist Corps Research Course, Washington, D.C., August, 1991.

27. Rice, V. J. and P.M. Sind. Ergonomic worksite risk analysis workshop. American Occupational Therapy Association Annual Conference, Cincinnati, OH, June, 1991.

28. Rice, V. J. The occupational therapist as an ergonomic consultant: Worksite evaluation, job analysis, medical management, and education/training. Army Environmental Hygiene Agency, Principles of Ergonomics Course, Towson, MD, July, 1991.

29. Rice, V. J. Worksite Analysis and Ergonomics. Round table discussion chair for the Occupational Medicine Conference, USARIEM, June, 1991.

30. Rice, V. J. The occupational therapist as an ergonomic consultant and Ergonomic research at the U. S. Army Research Institute of Environmental Medicine. Army Environmental Hygiene Agency, Principles of Ergonomics Course, Aberdeen, MD, June, 1991.

31. Rice, V. J. The relationship between ergonomics and occupational therapy. Army Environmental Hygiene Agency, Principles of Ergonomics Course, Towson, MD, May, 1991.

32. Rice, V. J. Ergonomics-Worksite Evaluation. Army Academy of Health Sciences, Occupational Therapy Assistant Training Program, Ft Sam Houston, TX, March, 1991.

33. Sharp, M., J. Knapik and A. Schopper. Effects of 45 hours of continuous operations on 155mm Howitzer crew performance. Human Factors Society Annual Meeting, San Francisco, CA, September, 1991.

KEY BRIEFINGS:

34. MAJ Karl E. Friedl, Ph.D. "Proposed revisions to accession (AR 40-501) and retention (AR 600-9) body weight and body fat standards." To BG Blanck, OTSG, Falls Church, VA, 1 April 1991.

35. MAJ Karl E. Friedl, Ph.D. Proposed revisions to accession (AR 40-501) and retention (AR 600-9) body weight and body fat standards." To LTG Reno, DCSPER, Washington, D.C., 2 April 1991. Briefing recommendations were approved.

36. MAJ Karl E. Friedl, Ph.D. Brief on findings of USARIEM Ranger School Study to COL Maher, Commandant, Ranger School, Ft. Benning, GA, 1 October 1991.

37. MAJ Karl E. Friedl, Ph.D. Brief on field research concerning elite soldiers, to COL Webber, Combat Development, JFK Warfare Center, Fort Bragg, NC, 6 November 1991.

SIGNIFICANT TDY:

MAJ Karl E. Friedl, and Mr. Louis Marchitelli. Visit to Pennington Biomedical Center and attendance at the Pennington Conference. Baton Rouge, LA, 13-15 March 1991.

MAJ Valerie J. Rice. TDY with U.S. Army Environmental Hygiene Agency representatives to participate in a team approach to identify ergonomic risk factors associated with occupational cumulative trauma disorders in the DENTAC workforce. Ft Leonard Wood, 22-27 September 1991.

MAJ Valerie J. Rice. Briefing conference with Gerard F. Scannell, Assistant Secretary of the Occupational Safety and Health Administration, Department of Labor to discuss OSHA draft entitled, Ergonomics Program Management Recommendations for General Industry. Washington, D.C., 30 July 1991.

MAJ Valerie J. Rice. Recruiting trip for human research volunteers to Ft. Sam Houston, TX, 27 February-2 March 1991.

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MAJ Valerie J. Rice. Training course for AOTA accreditation evaluators. Phoenix, AZ, 17-20 January 1991.

PROFESSIONAL APPOINTMENTS/ACTIVITIES:

Patton, John F., Ph.D., Division Chief. Associate Editor, Journal Applied Sports Science Research, National Strength and Conditioning Association Journal; Reviewer, Aviation Space and Environmental Medicine, Military Medicine, Medicine and Science in Sports and Exercise, International Journal of Sports Medicine,and Journal of Applied Physiology.

Friedl, Karl. E., Ph.D., MAJ, MS, Research Physiologist. Associate Editor, Journal Applied Sports Science Research, National Strength and Conditioning Association Journal. Reviewer, Medicine and Science in Sports and Exercise, Physician and Sportsmedicine, International Journal Sports Medicine.

Harman, Everett A., Ph.D., Research Physiologist. Adjunct Assistant Professor, Sargent College of Allied Health Professions, Boston University. Vice-President for Basic and Applied Research, and Member, Tests and Measurements, and Research Committees, National Strength and Conditioning Association. Member, Awards Committee, New England Chapter, American College of Sports Medicine. Senior Editor, Journal Applied Sport Science Research. Associate Editor, National Strength and Conditioning Association Journal and Conditioning for Volleyball. Reviewer, Medicine and Science in Sports and Exercise.

Valerie J. Rice, Ph.D., MAJ, SP, Occupational Therapist. Member, Army Medical Specialist Corps Research Advisory Group; Army Medical Specialist Corps Mentorship Program; Human Factors Society - Special Interest Group on Medical Systems and the Functionally Impaired. Administration and Special Expertise Representative to the American Occupational Therapy Association Roster of Accreditation Evaluators. Associate, Human Engineering Committee Association for the Advancement of Medical Instrumentation. Reviewer for annual conference presentations and submissions for publication by the American Occupational Therapy Association. Book reviewer: Ergonomics

Abstracts, International Ergonomics Association; Human Factors Society Bulletin, Human Factors Society; American Journal of Occupational Therapy, American Occupational Therapy Association.

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RESEARCH PROGRAMS AND OPERATIONS DIVISION

SIGNIFICANT RESEARCH FINDINGS/DEVELOPMENTS:

1. An experimental sock system has been developed to decrease blisters, tendinitis and lace irritation in soldiers during road marching. This high moisture transfer, stand-off system keeps the feet dry, provides a non-skin interface for differential motion and isolation of the foot from the boot. Fitting of larger boots is required to accommodate the bulk of these socks. User evaluations have shown the effectiveness of the system. The system is being high-use units such as SF, Ranger and Seals in cold- wet and -dry and hot-wet and -dry environments. Future plans call for evaluation in an Army basic training unit and a Marine Corps female basic training unit test. The system has been submitted for patent by the designer.

2. Data collection was completed for a study entitled: Effects of an Antiperspirant Applied to the Feet of Soldiers Exercising in a Warm Environment. This study was a follow-up to our first investigation in which we showed that antiperspirants applied to the feet curtailed perspiration by 50%. Furthermore, the initial study showed a tendency for less blister formation on the feet of volunteers using the antiperspirant. Therefore, the current study was designed to investigate the potential of antiperspirants to reduce both the severity and numbers of foot blisters. This was accomplished with volunteers carrying a field load while walking on a treadmill in a warm climatic chamber. The study was designed also to answer several secondary questions, such as the antiperspirant effect on the growth of bacteria and also the effect on foot temperatures. Occupational Medicine Division conducted the experimentation with personnel from Animal Resources acting as antiperspirant consultants and co-investigators. This research was USARIEM's in-kind contribution to the Cooperative R&D Agreement with Gillette Company.

3. USARIEM signed a Cooperative Research and Development Agreement with Dow Corning Corporation. This is a vehicle by which the Army and private industry may legally transfer

technology to each other. This particular agreement was structured so that Dow Corning would contribute their antiperspirant formulations, as well as their expertise in the area of antiperspirant science. USARIEM would contribute personnel, equipment, and expertise in testing antiperspirants for their effect on foot sweating and blister formation.

PUBLICATIONS:

1. Darrigrand, A.A., K.L. Reynolds, R. Jackson, M.P. Hamlet and D.E. Roberts. Efficacy of Anti-perspirants on Feet. Military Medicine. (In Press).

KEY BRIEFINGS:

2. Murray P. Hamlet, D.V.M. Briefing the FBI Hostage Rescue Team on Cold Weather Clothing, Injuries and Prevention, Quantico, VA, 17-18 January 1991.

3. Murray P. Hamlet, D.V.M., John F. Glenn, Ph.D, LTC, MS, and Richard L. Burse, Sc.D. USARIEM presentation to First Annual Massachusetts Federal Technology Transfer Meeting, sponsored by Massachusetts Technology Development Council and Massachusetts Military Coalition (of DoD laboratories) at Worcester Polytechnic Institute, Worcester, MA, 4 May 1991.

SIGNIFICANT TDY:

Richard L. Burse, Sc.D. To US Army Training program for Scientific and Technical Information Officers, Bethesda, MD, 18-22 February 1991.

Richard L. Burse, Sc.D. To represent USARIEM at USAMRDC working groups on acquisition Management, Small Business Innovative Research and Technology Transfer, Frederick, MD, 8-9 May and 4-6 October 1991.

Richard L. Burse, Sc.D. and Gerald P. Krueger, COL, MS. To represent USARIEM in All-Army Technology Transfer Meeting, Arlington, VA, 16-18 June 1991.

Darrigrand, Andre A., D.V.M. Applied Research Ethics National Association and Public Responsibility In Medicine & Research Conference relating to multiple aspects of legal ramifications in the use of research animals Boston, MA, 20-22 March 1991.

Darrigrand, Andre A., D.V.M. American Association for Laboratory Animal Science Conference . Emphasis on management and scientific considerations of laboratory animals, Buffalo, NY, 20-24 October 1991.

Murray P. Hamlet, D.V.M. To lecture and participate in the Nordic Conference on Cold, Tromso, Norway, 29 January - 3 February 1991.

Murray P. Hamlet, D.V.M. Attend the Army Science Board Summer Study on "The Soldier as a System", Washington, DC, 6-7 February 1991.

Murray P. Hamlet, D.V.M. To confer on the development of sock for soldier use at Senneca Sock Mills, Senneca, NY, 14-15 February 1991.

Murray P. Hamlet, D.V.M. To coordinate sock evaluation at the Ranger School, Ft. Benning, GA, 12-13 August 1991.

Murray P. Hamlet, D.V.M. To attend the Special Operations Requirement Planning Briefing, Tampa, FL, 14-16 August 1991.

Murray P. Hamlet, D.V.M. To present USARIEM information at the Surgeons Conference, Tampa, FL, 24-25 September 1991.

SIGNIFICANT VISITORS:

David P. Martin, V.M.D., Dupont Merck Pharmaceutical Co., and Richard H. Latt, D.V.M., McGill University, Montreal, Canada, made a site visit on behalf of AAALAC, 23 July 91.

MAJ Nathaniel Powell, US Army Medical Research and Development Command, Fort Detrick, Frederick, MD. Staff-assistance visit to review policies and procedures relating to the animal colony, 25 Sep 91.

PROFESSIONAL APPOINTMENTS/ACTIVITIES:

Hamlet, Murray P., D.V.M., Division Director. Recipient, "The Argentine Surgery Award", from the Argentine Academy of Surgery, Buenos Aires, Argentina. Reviewer, American Society for Testing and Materials.

Burse, Richard L., Sc.D., Research Physiologist. Member, Past-Presidents' Advisory Committee, New England Chapter, Human Factors Society. Reviewer, Journal of Applied Physiology and Human Factors.

Darrigrand, Andre A., D.V.M., MAJ, VC, Division Chief. Member, Forum Committee, American College of Laboratory Animal Medicine.

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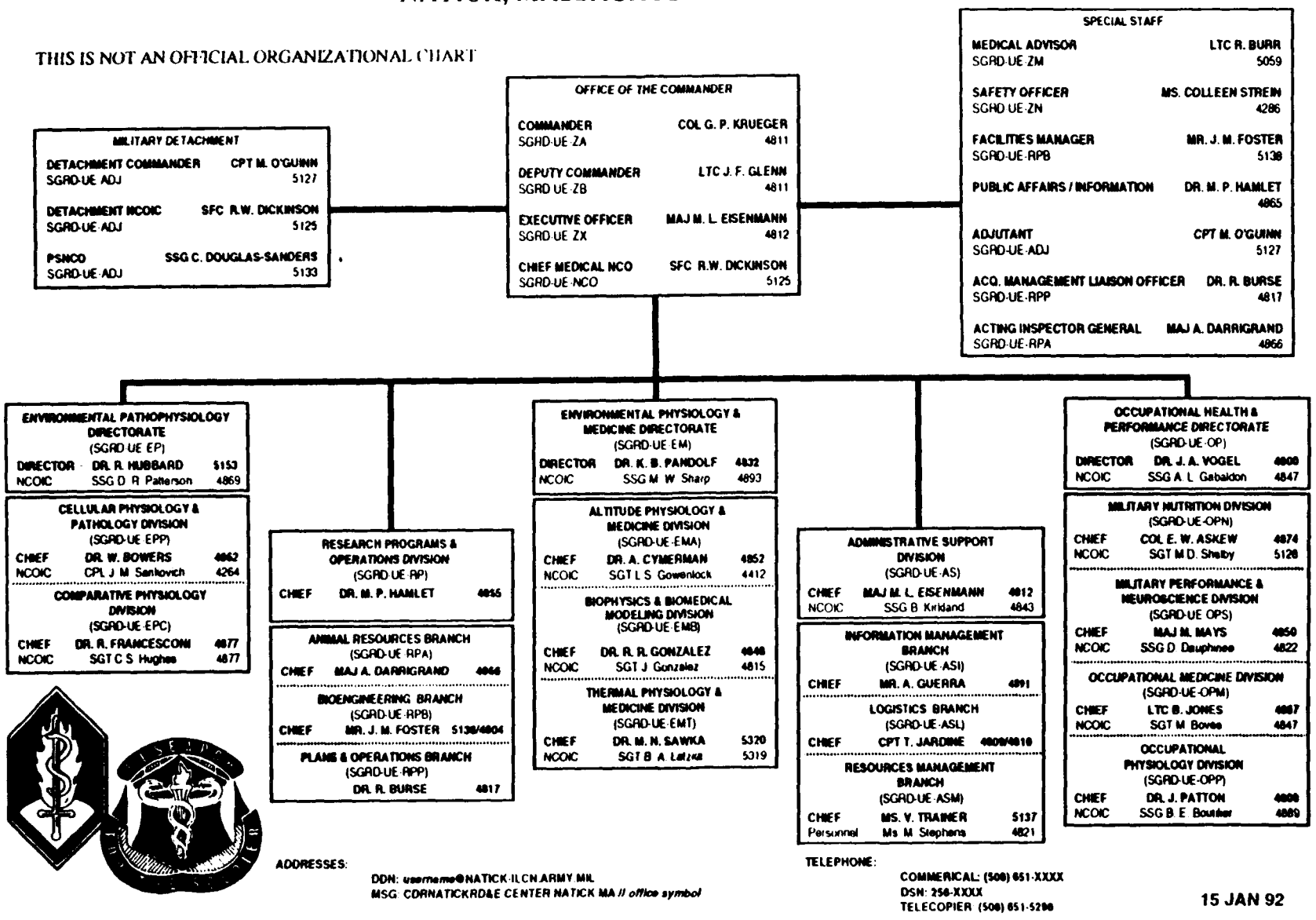

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