ANNUAL HISTORICAL REPORT
CALENDAR YEAR 1986

U S ARMY RESEARCH INSTITUTE
OF
ENVIRONMENTAL MEDICINE
Natick, Massachusetts

UNITED STATES ARMY
MEDICAL RESEARCH & DEVELOPMENT COMMAND

ANNUAL HISTORICAL REPORT - AMEDD ACTIVITIES

RCS MED-41 (R4)

U.S. ARMY RESEARCH INSTITUTE OF ENVIRONMENTAL MEDICINE

NATICK, MASSACHUSETTS 01760

CALENDAR YEAR 1986

USARIEM
CY86

TABLE OF CONTENTS

GENERAL INFORMATION

ORGANIZATION

The United States Army Research Institute of Environmental Medicine (USARIEM) is organized with an Office of the Commander/Scientific Technical Director, seven Research Divisions and a Research Support Division consisting of five functional Branches. Organizational chart of USARIEM, dated 1 October 1986 is attached as Appendix A.

LOCATION

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

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 Surgeon General, 1 December 1961, assigned USARIEM to the United States Army Medical Research and Development Command, Washington,

c. The USARIEM was last reorganized under General Order No. 32, Department of the Army, Headquarters, U.S. Army Medical Research and Development Command on 1 August 1975.

TENANCY

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

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

USARIEM
CY86

MISSION

Conducts research on the effects of temperature, altitude, work and nutrition on the health and performance of the individual soldier and combat crews operating Army systems. Assesses decrements to soldier or combat crew performance caused by the synergy of environmental extremes protective measures used in NBC sustained operations. Conducts research on the biomedical processes limiting physical performance to determine physical fitness requirements and seek solutions to medical problems related to physical training and exercise. Defines the complex interaction of environmental/operational stress and Army systems and develops, evaluates and assists in the implementation of strategies designed to protect the soldier and enhance performance. In coordination with the Natick Research, Development & Engineering Center (Natick) and through liason with other Federal agencies, conducts research to develop the technology base required to evaluate feeding strategies for operation rations and supplements to minimize soldier performance decrements under sustained combat conditions and discharge the Army Surgeon General's responsibilities as DOD executive agent for nutrition. Assists Natick 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.

USARIEM
CY86

PERSONNEL

STRENGTH AS OF: 31 December 1986

CIVILIANS	AUTHORIZED	ACTUAL
SES	1	1
GM	7	7
GS	69	67
WG	2	2
TPT	2	29
	81	106

OFFICERS	AUTHORIZED	ACTUAL
MC	5	4
MS	12	15
VC	2	1
	19	20

ENLISTED	AUTHORIZED	ACTUAL
	53	46

	AUTHORIZED	ACTUAL
TOTAL	153	172

USARIEM
CY86

KEY STAFF AS OF: 31 DECEMBER 1986

David D. Schnakenberg, COL, MS, Ph.D., Commander and Scientific/Technical Director

Richard G. Allen, MAJ, MS, Ph.D., Executive Officer and Director, Research Support Division

Richard W. Weringo, SFC, Senior Medical NCO

James A. Vogel, Ph.D., Ph.D., Director, Exercise Physiology Division

Kent B. Pandolf, Ph.D., Director, Military Ergonomics Division

Richard R. Gonzalez, Ph.D., Chief, Biophysics Branch, Military Ergonomics Division

Michael N. Sawka, Ph.D., Chief, Physiology Branch, Military Ergonomics Division

Roger W. Hubbard, Ph.D., Director, Heat Research Division

Allen Cymerman, Ph.D., Director, Altitude Research Division

Murray P. Hamlet, D.V.M., Director, Cold Research Division and Acting Chief, Cold Injury Branch

Wilbert D. Bowers, Ph.D., Chief, Experimental Pathology Branch, Cold Research Division

Neil W. Ahle, CPT, VC, Acting Chief, Animal Care Branch, Cold Research Division

Eldon W. Askew, LTC, MS, Ph.D., Director, Military Nutrition Division

Terry M. Rauch, MAJ, MS, Ph.D., Director, Health & Performance Division

RESEARCH SUPPORT DIVISION:

Adjutant, Detachment Commander (vacant)
John P. Cusack, CPT, MS, C, Program & Budget Branch
Carol A. Joriman, 1LT, MS, Chief, Information Management Branch
Deborah A. Gilbertson, CPT, MS, Chief, Logistics Branch
John M. Foster, Chief, Bio-Engineering Branch
Marie E. Stephens, Chief, Administrative Services Branch

ALLOCATION AND FUNDING

USARIEM - FY1986 PROGRAM

DBA PROJECT NO. & TITLE	FUNDS
3A161101A91C - In-House Laboratory Independent Research	$ 175,000
3M161102BS10 - Research on Military Disease, Injuries and Health Hazards	2,274,000
3M162734A875 - Medical Defense Against Chemical Agents	233,000
3E162777A878 - Health Hazards of Military Materiel	363,000
3E162777A879 - Medical Factors Enhancing Soldier Effectiveness	1,803,000
3M263763D819 - Medical Protection Using Nutrition	337,000
3M263764D995 - Med/Chem Life Support Mat.	721,000
P665801.M22 - Special Purpose Equipment	235,000
Total Program	$ 6,141,000

SUPPLY AND MAINTENANCE ACTIVITIES

During CY86 a total of 1,960 lines were processed by the Logistics Branch as indicated below:

Non-Expendables - 378 Requests

Expendables - 1,582 Requests

During CY86 the Logistics Branch processed 183 requests for 282 items of excess equipment, representing $270,745.60.

During CY86, a total of 2253.1 hrs were used by the Medical Maintenance Section as indicated below:

Scheduled services: 107.7 hrs
Unscheduled services: 1176.1 hrs

There were 405 items processed for calibration.

BUILDING AND FACILITY EQUIPMENT

DESIGN AND DEVELOPMENT:

The Bioengineering Branch contributed to the design and development of the following for the period, CY86:

a. Automated inspiratory occlusion valve to measure airway resistance.

b. Electrical penetration system for the Altitude Chamber.

c. Automated ball drop counter to measure hand-eye coordination.

d. An extremity tremor device to measure fatigue.

BUILDING MODFICATIONS:

a. Environmental chambers 024A and 024B were removed and construction was begun on one large chamber at a cost of $400,000.

b. Two environmental heat chambers, 232A and 232C, were completely renovated with windspeed and microprocessor controls.

c. Construction was completed on the $32,00 animal environmental chamber.

d. Installation of the cooling tower was completed and put into operation.

e. Room 104 was renovated to accept installation of new computer-aided drafting system.

CHANGE OF COMMAND

A Change of Command ceremony was held at the U.S. Army Research Institute of Environmental Medicine on June 25, 1986 in honor the outgoing Commander, Colonel Brendan E. Joyce and the incoming Commander, Colonel David D. Schnakenberg. Major General Garrison Rapmund, Commander of the U.S. Army Research and Development Command provide the opening remarks. Colonel Joyce received his Ph.D. in Biochemistry from the University of California and was commissioned into the Army Medical Service Corps in 1956. He came to USARIEM in February, 1980 as Special Projects Officer and became Executive Officer in 1982. He commanded the Institute since November 1984. Colonel Schnakenberg received his Ph.D. in Metabolic Physiology from the University of California, was a Distinguished Military Graduate of the University of Missouri ROTC Program, and received a Regular Army Commission as a Chemical Corps Officer in 1963 and subsequently branch transferred to the Medical Service Corps. He came to USARIEM in July of 1984 as head of the Nutrition Research Task Force and subsequently became Director of the newly formed Military Nutrition Division before assuming Command of the Institute in 1986.

USARIEM 25TH ANNIVERSARY

On 28-29 October 1986 approximately 50 visiting dignitaries gathered with the USARIEM staff to acknowledge and celebrate the twenty-fifth anniversary of the founding of USARIEM which occurred on 1 July 1961. The visitors included the present and several former commanders of the U.S.Army Medical Research and Development Command, the majority of the former commanders of USARIEM, prominent environmental and exercise physiologists from around the country, and others who were associated with the Institute in its developmental years. The two-day program consisted of addresses on the scientific history and accomplishments of the Institute by individuals who were instrumental in their occurrence, perspectives on the current and future programs of the Institute by the current Division chiefs, and several extremely informative and witty accounts of USARIEM's past as described by Dr. William Doolittle of Fairbanks, Alaska and Dr. R.J.T. Joy of Betheseda, Maryland. At a banquet on the evening of 28 October, Dr. James A. Vogel, Chairman of the anniversary committee, presented an inscribed plaque to each of the past Commanders on behalf of the staff of the Institute. In commemoration of the 25th anniversary, a written history of the Institute was prepared and distributed to all attendees; an abbreviated version of this was also published by the American Physiological Society in the commemorative edition of The Physiologist (Vol. 29, No. 5, Suppl., 1986). The conclusion of that manuscript sums up USARIEM's aspirations for the future: "With its current support, technical research, and administrative staff, USARIEM looks forward to another quarter-century of scientific accomplishments, scholarly excellence, professional recognition, and, most importantly, important contributions to the health and safety of United States's soldiers in any global environment.

USARIEM
CY86

OFFICE OF THE COMMANDER

PUBLICATIONS:

None.

ABSTRACTS:

Carlson, D.E., D.D. Schnakenberg, M. Sawyers, T. Dugan, K. Simmonds. Effectiveness of combat field feeding system in meeting nutritional requirements of soldiers. New Visions, New Ventures, American Dietetic Association Abstracts, p. 80, 1986.

PRESENTATIONS:

Schnakenberg, D.D., Recent Developments in Military Nutrition Research, Presentation to Washington, DC, Chapter of Institute of Food Technologists, 17 Nov 1986.

Schnakenberg, D.D., Recent Developments in Military Nutrition Research. Presentation to Annual Symposium of the American Health Foundation, New York, N.Y., 2 Dec 1986.

KEY BRIEFINGS:

COL Schnakenberg briefed Mr. Seymour Lorber, Deputy Chief of Staff, Product Assurance and Testing, U.S. Army Materiel Command on Nutritional Aspects of Combat Ration Testing, Alexandria, VA, 8 July 1986.

COL Schnakenberg briefed LTG Peter Burbules, Deputy Commander, U.S. Army Materiel Command, on Nutritional Aspects of Combat Ration Testing Program, Alexandria, VA, 16 July 1986.

COL Schnakenberg briefed LTG Peter Burbules, Deputy Commander, U.S. Army Materiel Command, on Nutritional Aspects of Meal Ready to Eat (MRE) Testing and Procurement Program, Alexandria, VA, 11 September 1986.

COL Schnakenberg briefed MG Skeen, Commander, TROSCOM, on Nutritional Aspects of MRE at Materiel Acquisition Review Board (MARB) Meeting, St. Louis, MO, 9 October 1986.

COL Schnakenberg briefed LTG Peter Burbules, Deputy Commander, U.S. Army Materiel Command, and LTG Skibbie, DCSRDA, HQDA, on Nutritional Aspects of MRE at Materiel Acquisition Review Board (MARB) meeting, Alexandria, VA, 7 November 1986

OFFICE OF THE COMMANDER

SIGNIFICANT TDY:

COL D. D. Schnakenberg and MAJ R.G. Allan attended the USAMRDC Commander's Conference at FT Detrick, MD., 1-3 Oct 1986.

COL D.D. Schnakenberg chaired the 4th Meeting of NATO Panel VIII, Research Study Group-8, Nutritional Aspects of Military Feeding, held at Defence and Civil Institute of Environmental Medicine, Downsville, Ontario, Canada, 6-11 Oct 1986.

COL D.D. Schnakenberg represented DoD at the Quarterly Meeting of the Interagency Committee on Human Nutrition Research, Washington, DC, 14 Oct 1986.

SIGNIFICANT VISITORS:

COL Karengo Hermenejldi, Republic of Burundi, 4 April 1986.

Dr. Rita Crow, Defense Research Establishment Ottawa, Canada, 28 April 1986.

Dr. Werner Gehrmann, Dr. Juergen Mecheels and Dr. Karl-Heinz Umbach, Institute of Textile Research, Hohenstein, FRG, 28 April 1986.

COL Yair Shapiro and MAJ Burstein, Israeli Defense Forces, 24 May 1986.

Dr. Thomas Madsen, Danish Technical University, 26 May 1986.

Dr. Radomski, Technical Director, Defence and Civil Institute of Environmental Medicine, Downsview, Ontario, Canada, 17 June 1986.

Dr. Bjoern Olesen, Bruel & Kjaer A/S, Denmark, 20 June 1986.

MG(ret) Pierre Ricaud, French Ministry of Defense, 24 June 1986.

COL Yair Shapiro, Israeli Defense Forces, 7-8 July 1986.

Dr. Shu-Tsu Hu, Shanghai Institute of Physiology, Chinese Academy of Sciences, Shanghai Peoples Republic of China, 4 August 1986.

GEN Hong Xuezhi, Director of General Logistics Department and 14 others, including 4 generals, Peoples Republic of China, 16 October 1986

BG Chen Ning-Quing and Dr. Ruan Jin Xiu, Academy of Military Medical Sciences, Beijing, Peoples Republic of China, 19 December 1986.

Dr.Chao Fu-huan, Institute of Hygiene and Environmental Medicine, Tianjin, Peoples Republic of China, 19 December 1986

OFFICE OF THE COMMANDER

SIGNIFICANT EVENTS:

Hosted USARIEM "Current Concepts in Environmental Medicine " course, 12-16 May 1986. (20 Attendees)

Change of Command - COL David D. Schnakenberg, MS, assumed Command of USARIEM from COL Brendan J. Joyce, MS, 25 June 1986.

Hosted 25th Anniversary of USARIEM Symposium, 28-29 October 1986.

PROFESSIONAL APPOINTMENTS:

COL David D. Schnakenberg served as Chairman, NATO Panel VIII, Research Study Group-8, Nutritional Aspects of Military Feeding.

COL David D. Schnakenberg served as DoD Representative to Interagency Commitee on Human Nutrition Research.

COL David D. Schnakenberg, served as USAMRDC member to DoD Nutrition Committee.

ALTITUDE RESEARCH DIVISION

SIGNIFICANT RESEARCH FINDINGS/DEVELOPMENTS:

During the course of three-weeks residence at Pikes Peak (elevation 4300 m), soldiers consumed a controlled diet and performed moderate cycle exercise. Measurements of 3-methyl histidine, a urinary marker for muscle catabolism, indicated no significant reductions in muscle mass associated with the small 1.2% loss in subject body weight. The results indicate that if adequate and acceptable nutrition is provided to individuals at 4300 m for a moderate length of time then muscle wasting can be prevented together with overall weight loss.

Soldiers who have elevations in diastolic blood pressure of 20 torr or more during a cold pressor test (CPT) have an 80-90% probability of suffering moderate Acute Mountain Sickness symptoms upon subsequent exposure to high altitude (4300-4500 m). Soldiers with less than 20 torr increase test have only a 40-50% probability of acute mountain sickness. Therefore, CPT at sea level may be used to identify approximately 1/2 of the individuals who will be ill at altitude, but further validation is necessary.

Naproxan, a prostaglandin inhibitor administered to subjects in a double-blind crossover study conducted at 4750 m, had no effect on the incidence of AMS. Retinal artery diameters measured from projected fundus photographs were increased 21% over sea-level controls, suggesting significant increases in brain blood flow with no discernible drug effect.

Spironolactone, an aldosterone antagonist purported to be effective in mitigating acute mountain sickness by altering potassium excretion and causing a mild diuresis, did not affect cardiocirculatory responses such as stroke volume, cardiac output and calf blood flow with upright tilt in soldiers participating in a double-blind crossover study at 4600 m simulated altitude. Spironolactone was found to be beneficial for the prevention of AMS in only a small portion of the subjects.

Propranolol, a beta adrenergic blocker used to treat hypertension, did not impair maximal and submaximal exercise oxygen uptakes in normal soldiers exposed to 4300 m despite significant reductions in resting and exercise heart rates. No interference was found with the soldiers ability to maintain orthostatic tolerance.

ALTITUDE RESEARCH DIVISION

SIGNIFICANT RESEARCH FINDINGS/DEVELOPMENTS:

Cerebral blood flow velocities were measured in subjects at sea level and during the course of 12 days at 4300 m with the hypothesis that changes in the respiratory gases and oxygen content contributed to the increase in cerebral blood flow and oxygen delivery to the brain. Although no association was found between cerebral blood velocity, changes in respiratory gases, and acute mountain sickness symptom scores, the increase in cerebral blood flow represents an important component of altitude acclimatization.

The incidence of retinal pathology was studied during Operation Everest II in eight subjects progressively decompressed to an altitude equivalent to 8848 m over the course of 40 days. A gradual progression of retinal blood vessel involvement was observed ranging from increased tortuosity to frank (Class IV) hemorrhages in half to all the subjects as the elevation increased to 7600 m. At no time were the hemorrhage symptomatic. These hemorrhages were observable but resolving 72 h post exposure. Results indicated that retinal hemorrhages will occur in almost all individuals made severely hypoxic for a sufficient length of time; that they are almost always asymptomatic unless they occur in the macula; and that they will resolve relatively quickly upon return to sea level.

Maximal oxygen uptake was studied in five OEII subjects at various elevations up to 8848 m. At this elevation maximal oxygen was reduced 72% compared to sea level with subjects receiving no supplemental oxygen. The range of maximal values observed at sea level (SEM 196 ml/min) was significantly reduced (SEM 79 ml/min) at 8848 m. Sea-level physical fitness was judged not to be a criteria for the capacity to exercise at very high altitudes.

Oxygen uptake during submaximal exercise on OEII can be maintained by marked reduction in mixed venous oxygen tension in spite of the severe arterial hypoxemia and a normal cardiac output.

In eight OEII subjects the pulmonary ventilation/perfusion distribution was estimated using the inert gas elimination technique as several levels of decompression. The results indicated a variable but increasing mismatch of pulmonary ventilation to perfusion with the combination of long term altitude exposure and submaximal exercise that is consistent with the development of interstitial edema.

ALTITUDE RESEARCH DIVISION

SIGNIFICANT RESEARCH FINDINGS/DEVELOPMENTS:

The effect of dexamethasone on the hemodynamic and sympathoadrenal responses of 8 subjects was examined in a double-blind crossover study of 42 h exposure to 4570 m simulated altitude. Mean altitude pulse rates were significantly lower with dexamethasone. Dexamethasone also reduced urinary epinephrine excretion at altitude compared to sea level with no change in urinary norepinephrine. It is concluded that acute exposure to altitude is associated with a stimulation of the adrenal medulla and not the noradrenergic component of the sympathetic nervous system.

PUBLICATIONS:

Banderet, L.E., B.L. Shukitt, E.A. Crohn, R.L. Burse, D.E. Roberts and A. Cymerman. Effects of various environmental stressors on cognitive performance. Proc. Military Testing Assoc. pp. 592-597, 1986.

Fulco, C.S., A. Cymerman, R. Larsen and P.B. Rock. The effect of spironolactone on the cardiocirculatory responses to upright tilt at sea level and at simulated altitude. Aviat. Space Environ. Med. 57:787-91, 1986.

Hamilton, A.J., A. Cymerman and P.M. Black. High Altitude Cerebral Edema. Neurosurgery 19:841-849, 1986.

Jones, B.J., Larsen, R., P.B. Rock, C.S. Fulco, B. Adelman, A.J. Young and A. Cymerman. The effect of spironolactone on acute mountain sickness. Aviat. Space Environ. Med. 57:543-47, 1986.

Meehan, R.T., A. Cymerman, P.B. Rock, C.S. Fulco, J. Hoffman, C. Abernathy, S. Needleman and J.T. Maher. The effect of naproxen on acute mountain sickness and vascular responses to hypoxia. Am. J. Med. Sci. 29:15-20, 1986.

Moore, L.B., A. Cymerman, H. Shao-Yung, E.R. McCullough, R.G. McCullough, J.T. Reeves, P. B. Rock, A.J. Young, P.M. Young and J.V. Weil. Propranolol does not impair exercise oxygen uptake in normal men at high altitude. J. Appl. Physiol. 61:1935-1941, 1986.

ABSTRACTS:

Balcomb, A., K.Killian, A. Cymerman, C.S. Houston and J.R. Sutton. Ventilation and dyspnea during exercise at extreme simulated altitude: Operation Everest II. Canad. J. Appl. Physiol. 51:43, 1986.

ALTITUDE RESEARCH DIVISION

ABSTRACTS:

Burse, R.L., P.B. Rock and C.S. Fulco. Ability of cold pressor test (CPT) to predict susceptibility to acute mountain sickness (AMS). Fed. Proc. 45:884, 1986.

Claybaugh, J.R., D.P. Brooks, J.C. O'Brien, A. Cymerman and S.A. Cucinell. Effects of acetazolamide on renin, aldosterone, and sodium and potassium balance at altitude. Fed. Proc. 45:906,1986.

Cymerman. A., P.B. Rock, P.M. Young, J.R. Sutton and M.K. Malconian. Operation Everest II: Maximum oxygen uptake at extreme altitude. Fed. Proc. 45:882, 1986.

Fulco, C.S., A. Cymerman, J.T. Reeves, P.B. Rock, L.A. Trad, P.M. Young and M.A. Hameed. Propranolol does not effect orthostatic tolerance at sea level or high altitude. Fed. Proc. 45:1030, 1986.

Groves, B.M., J.R. Sutton, P. Wagner, A. Cymerman, M.K. Malconian, P.B. Rock, P.M. Young, C.S. Houston and J.T. Reeves. Operation Everest II: Elevated pulmonary vascular resistance during exercise at extreme altitude unresponsive to acute oxygen breathing. Am. Rev. Resp. Dis. 133:A200, 1986.

Houston, C.S., A. Cymerman and J. Sutton. High altitude physiology - Operation Everest II. Med. Sci. Sports Exer. 18:S1, 1986.

Hoyt, R.W., J. Lubowitz, T. Asakura and T.P. Stein. Fuel metabolism during severe rowing exercise. Fed. Proc. 45:646, 1986

Huang, S.Y., L.G. Moore, R.E. McCullough, R.G. McCullough, A.J. Micco, C.S. Fulco, A. Cymerman, J.V. Weil and J.T. Reeves. Cerebral flow velocity at high altitude. Fed. Proc. 45:1030, 1986.

Malconian, M.K., P.B. Rock, A. Cymerman, J.T. Reeves, J.R. Sutton, P.M. Young, L.A. Trad, V.A. Forte, H. Donner and C.S. Houston. Operation Everest II: Hyperventilation upon return to sea level after a simulated ascent of Mt. Everest. Fed. Proc. 45:883, 1986.

Malconian, M.K., P.B. Rock, A. Cymerman, J.T. Reeves, J.R. Sutton, P.M. Young, L.A. Trad, V.A. Forte, H. Donner and C.S. Houston. Operation Everest II: Alveolar gases and arterial blood gases throughout a simulated ascent of Mt. Everest. Am. Rev. Resp. Dis. 133:A200, 1986.

ALTITUDE RESEARCH DIVISION

ABSTRACTS:

Rock, P.B., R.T. Meehan, M.K. Malconian. H. Donner, L.A. Trad, B.A. Ruscio, J.R. Sutton, C.S. Fulco, P.M. Young, R.L. Burse, A. Cymerman and C.S. Houston. Operation Everest II: Incidence of retinal pathology during a simulated ascent of Mt. Everest. Fed. Proc. 45:1030, 1986

Rock, P.B., M.K. Malconian, H. Donner, B.M. Groves, J.T. Reeves, J.R. Sutton, J.K. Alexander, H.N. Hultgren, A. Cymerman and C.S. Houston. Operation Everest II: Electrocardiography during maximal exercise at extreme altitude. Med. Sci. Sports Exer. 18:S574, 1986.

Sutton, J.R., A. Cymerman, B.M. Groves, M.K. Malconian, J.T. Reeves, P.D. Wagner, P.M. Young and C.S. Houston. Severe arterial hypoxemia at rest and during exercise at extreme simulated altitude - Operation Everest II. Am. Rev. Respir. Dis. 133:Z200, 1986.

Sutton, J.R., J.T. Reeves, P.D. Wagner, B.M. Groves, A. Cymerman, P.M. Young, M.K. Malconian and C.S. Houston. Oxygen uptake during exercise at extreme simulated altitude maintained by marked reduction in mixed venous oxygen tension - Operation Everest II. Fed. Proc. 45:882, 1986.

Sutton, J.R., A. Cymerman, P.B. Rock, P.M. Young, A. Young, P. Bangs and C.S. Houston. Maximum ventilation, lactate and perceived exertion at extreme simulated altitude - Operation Everest II. Med. Sci. Sports Exerc. 18:S585, 1986.

Sutton, J.R., H.J. Green, P.M. Young, P.B. Rock, A. Cymerman and C.S. Houston. Plasma vasopressin, catecholamines and lactate during exhaustive exercise at extreme simulated altitude - Operation Everest II. Canad. J. Appl. Physiol. 51:43, 1986.

Wagner, P.D., J.T. Reeves, J.R. Sutton, A. Cymerman, B.M. Groves, M.K. Malconian and P.M. Young. Possible limitation of maximal O_2 uptake by peripheral tissue diffusion. Am. Rev. Respir. Dis. 133:A202, 1986.

Wagner, P.D., J.R. Sutton, J.T. Reeves, A. Cymerman, B.M. Groves and M.K. Malconian. V_A/Q inequality at rest and during exercise throughout a simulated ascent of Mt. Everest. Fed. Proc. 45:882, 1986.

Wagner, P.D., J.R. Sutton, M.K. Malconian, A. Cymerman, B.M. Groves and J.T. Reeves. Lung Volumes and flow rates in man during a simulated ascent of Mt. Everest. Am. Rev. Resp. Dis. 133:A76, 1986.

ALTITUDE RESEARCH DIVISION

ABSTRACTS:

Weil, J.V., L.G. Moore, A. Cymerman, S.Y. Huang and J.T. Reeves. Beta-sympathetics increase metabolic rate and ventilation at high altitude but acclimatization is unaffected. Fed. Proc. 45:883, 1986.

Young, A.J., J.T. Reeves, A. Cymerman, H.S. Yung, R.W. McCullough, R.G. McCullough, L.G. Moore, P.B. Rock, P.M. Young, D. Bloedow and J.V. Weil. No propranolol effect on O_2 uptake during exercise at high altitude. Fed. Proc. 45:883, 1986.

Young, P.M., P.B. Rock, G. Farese, L.A. Trad and A. Cymerman. The effect of submaximal exercise at 4300 m altitude on levels of plasma substrates and metabolites. Fed. Proc. 45:1030, 1986.

KEY BRIEFINGS:

Richard L. Burse, Sc.D. Human factors in the Army R&D cycle. New England Regional Chapter of the Human Factors Society, June 1986.

Reed W. Hoyt, Ph.D. Different roles of fat and carbohydrate as fuel for exercise; Committee on Military Nutrition Research, National Research Council, USARIEM, Dec. 1986.

Paul Rock, MAJ, MC. Medical problems at high terrestrial elevations. U.S. Army School of Aviation Medicine, Ft. Rucker, AL, October 1986.

Sutton, J.R., A. Cymerman, P.B. Rock, P.M. Young, A.C. Balcomb and C.S. Houston. Operation Everest II. The XXIII World Congress of Sports Medicine, Brisbane, Australia, September, 1986.

SIGNIFICANT TDY

NONE.

SIGNIFICANT VISITORS:

LTC Robert Winslow, C. Blood Research Division, LAIR, San Francisco, CA

ALTITUDE RESEARCH DIVISION

PROFESSIONAL APPOINTMENTS/ACTIVITIES

Reed W. Hoyt, Ph.D. Full membership in The American Physiological Society and the International Society for Mountain Medicine.

Reed W. Hoyt, Ph.D. Appointed to the U.S. Rowing Association Sports Medicine Committee.

Richard L. Burse, Sc.D. President, New England Regional Chapter of the Human Factors Society.

Richard L. Burse, Sc.D. Adjunct Assistant Professor, Sargent College of the Allied Health Professions, Boston University.

Patricia M. Young, CPT, Ph.D. Adjunct Instructor, Uniformed Services University of the Health Sciences, Bethesda, MD.

Patricia M. Young, CPT, Ph.D. Membership in American College of Sports Medicine and American Chemical Society.

COLD RESEARCH DIVISION

SIGNIFICANT RESEARCH FINDINGS/DEVELOPMENTS:

A field study was conducted at Blanchfield Army Hospital, Ft. Campbell, KY to continue investigation into ethnic differences with regards to peripheral cold injury susceptibility. Thermal, cardiovascular and psychological data were collected on 42 subjects (23 Blacks and 19 Whites). The results suggest that there are no significant differences between Blacks and Whites in the peripheral circulatory, thermal and psychological responses to hand cooling in 5°C water.

Research was continued on Black-White peripheral vascular cold sensitivity in which data were gathered on test subjects bringing the total to 68 individuals (37 Whites and 28 Blacks). Analysis of data finds that finger temperatures during cold water hand immersion are not significantly different between ethnic groups. Important findings are that thermal responses of hands to cold demonstrate strong correlations to the individual's prior cold weather experiences.

The hardware was developed and purchased for a tissue freezing system that uses compressed air as the freezing medium. The use of this equipment was initiated on Hanford Miniature Swine to test its capabilities.

Low molecular weight Dextran is effective in reducing hematocrit and increasing tissue blood flow during recovery from hypothermia, but concern over hemolysis in the urine may preclude its use as a plasma expander during hypothermia.

Arterial capacitance (viscoelastic properties) decreases in aortic (large diameter) and femoral (small diameter) arteries as a result of modest cooling (hypothermia).

Classical conditioning is an effective treatment for Raynaud's Disease and the improvement may last as long as 12 months.

The prevailing concept of irreversible cell injury or cell death suggests that regardless of the cause of cell injury, several events occur which can lead to irreversibility. The initial event involves damage to cellular membranes and subsequently altered energy metabolism. Tissue damage due to

COLD RESEARCH DIVISION

SIGNIFICANT RESEARCH FINDINGS/DEVELOPMENTS:

heatstroke follows a similar pattern. Heat-induced cellular trauma also relates to membrane damage followed by loss of osmotic control and complex alterations in mechanisms of energy production. One approach to correcting a deficiency in high energy phosphates after hemorrhagic shock or hepatic ischemia, and in preparing organs for storage has been to perfuse with solutions containing ATP-$MgCl_2$. When this approach was applied to the isolated perfused liver model for heat injury, none of the parameters which monitor the condition of the liver during heat exposure were improved by perfusing ATP-$MgCl_2$. In fact, a rapid increase in hepatic pressure and adversely affected membrane permeability were noted. Since ATP-$MgCl_2$ treatment is reported to significantly reduce ischemic injury, but does not reduce heat-induced injury, some aspects of the mechanisms may differ. However, initial events appear to be similar.

Vascular microcorrosion casting techniques were used to evaluate damage to microcirculation in experimentally induced frostbite. This approach provides a quantifiable method for investigating vascular injury. The left hind limbs of anesthetized rats were cooled to -10°C or to -20°C. The right hind limbs served as controls. Temperatures in both limbs were measured with needle thermocouples placed under the gastrocnemius muscles and in some cases in the left hind footpads. All cooled limbs were rewarmed to 37°C in a 40°C water bath. Vascular microcorrosion casts from the left and right hind paws of groups were made using Batson's anatomical casting compound modified with methyl methacrylate. Scanning electron microscopic examination of the casts demonstrated dramatic differences between the vascular integrity of control paws and that of frozen paws. Freezing procedures destroyed most capillary beds. The weights of casts from frozen paws were also significantly different from those of control paws. It was concluded that this model for evaluating frostbite injury accurately demonstrates the extent of microvascular damage and has significant potential as a method for evaluating therapeutic drug regimes.

Prostacyclin (PGI_2) is a metabolite of the endothelium that influences blood flow in numerous ways. When subjected to stressful environments, its continued production is important to cardiovascular function. Many factors, to include temperature modulate PGI_2 synthesis, however, the cellular mechanisms that regulate PGI_2 production is not known. One overlooked feature is the relationship among PGI_2 synthetic rate, EC shape and degree of cell to cell contact. PGI_2 synthesis is markedly increased when ECs are in close contact with their neighbors and have assumed a more rounded and less

COLD RESEARCH DIVISION

SIGNIFICANT RESEARCH FINDINGS/DEVELOPMENTS:

flattened conformation. However, in the absence of cell contact, small, round ECs still generated significantly greater quantities of PGI_2. This suggested that cell shape modulation and not cell to cell contact was the paramount parameter associated with PGI_2 metabolic alterations. Further study revealed that the change in cell shape and PGI_2 production was also associated with an alteration in the distribution of the cytoskeletal constituent F-actin. A diffuse F-actin arrangement in small, round ECs supported greater PGI_2 production, than did the presence of many F-actin-myosin complexes (stress fibers) in large, flat ECs. It was concluded that EC shape was associated with the regulation of PGI_2 synthesis because shape changes altered F-actin distribution in a manner that influenced the PGI_2 cascade.

Actin fibers are cytoskeletal elements that contribute to intracellular structure and, thus, cellular form or shape. These structural elements also interact with numerous proteins, to include enzymes. Studies were conducted to determine if the relationship between F-actin arrangement and prostacyclin (PGI_2) metabolic modulations were the result of the direct actin effects on phospholipase A_2 (PLA_2). PLA_2 is the rate limiting PGI_2 cascade enzyme. Evidence was obtained to support the position that the activity of this enzyme could be altered by actin. Monomeric actin (G-actin) suppressed, while polymerized actin (F-actin) stimulated PLA_2 activity. However, when F-actin was complexed with myosin, the stimulatory effect of F-actin was significantly reduced. This indicated that PLA_2 activity may be modulated as a direct result of differences in the polymerized state of actin and the degree of actin-myosin stress fiber formation within ECs. This finding offers an explanation for the correlation among endothelial cell shape, F-actin distribution, and PGI_2 synthetic rate. Therefore, the design of pharmacological approaches for the management of PGI_2 synthesis during exposure to environmental extremes should perhaps be directed toward the maintenance of an EC actin cytoskeletal arrangement that supports enhanced PLA_2 activity.

Hypothermic conditions augment smooth muscle sensitivity to vasoactive amines, and serotonin (5-HT) is an element associated with the etiology of Raynaud's phenomenon, a disease characterized by enhanced cold sensitivity. This perhaps indicates that vasoactive amines like 5-HT may influence normal cold-induced vasoconstriction to reduced peripheral blood flow. When a rabbit limb was exposed to a 15°C water bath, studies were conducted to determine if 5-HT participated in normal peripheral cooling and if Ketanserin

COLD RESEARCH DIVISION

SIGNIFICANT RESEARCH FINDINGS/DEVELOPMENTS:

(KET), a 5-HT blocker modulated such cooling. KET treatment in the presence of exogenous 5-HT was associated with a significantly reduced cooling rate. In addition, KET treatment in the absence of exogenous 5-HT significantly elevated limb temperature. This suggested that endogenous 5-HT participated in limb cooling. Therefore, as noted for Raynaud's disease, 5-HT may also influence peripheral cooling of tissues free of such pathologies. Since KET treatment did not significantly alter rectal temperature in comparison to controls, such treatment with mild cold exposure may have potential in the regulation of peripheral temperature without increasing the risk of hypothermia.

A double-blind, randomized clinical trial of phenytoin (an anticonvulsive) agent) for the prevention of acute mountain sickness was conducted on 21 high altitude climbers, over 13 days, as they ascended from Beijing, China to Mount Everest base camp at 16,800 feet. The climbers who took phenytoin were less likely to have headache at base camp, however no other significant differences in symptoms were observed between the two groups.
The Heat-Pac individual casualty heater unit was found to function well at low barometric pressure (14,200 feet on Mt. McKinley). Carbon monoxide production is being evaluated.

Dexamethasone 4 mg every 6 hours by mouth was found to be an effective agent for the treatment of severe acute mountain sickness in soldiers who rapidly deployed to 14,200 feet in a clinical trial on Mount McKinley.

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PRESENTATIONS:

Daum, P. W. Bowers, Jr. and J. Tejada. Microcirculatory changes in acute frostbite evaluated by vascular microcorrosion casting techniques. New England Society for Electron Microscopy. Woods Hole, MA, May 1986.

USARIEM
CY86

COLD RESEARCH DIVISION

KEY BRIEFINGS:

Neil Ahle, CPT. Tissue Freezing Device, MG Ning-Qing Chen, Director, Academy of Military Medical Science, Peoples Republic of China, USARIEM, Natick, MA, December 1986,

Murray P. Hamlet, D.V.M. Cold Injury, Fort Rucker, Alabama, Aviation Medicine, March 1986.

Murray P. Hamlet, D.V.M. Cold Injuries Lecture, National Guard Annual Safety Meeting, Greenville, SC, April 1986.

Murray P. Hamlet, D.V.M. Cold Injuries Briefing to Medical Personnel prior to deployment to Antartica, Operation Deep Freeze, Port Hueneme, CA, August 1986.

Murray P. Hamlet, D.V.M. Cold Injuries Pre-Deployment Briefing, Operation Deep Freeze, Point Mugu, CA, September 86.

Murray P. Hamlet, D.V.M. Cold Weather Training to Marine Corps, Camp Lejeune, NC, October 1986.

Murray P. Hamlet, D.V.M. Cold Weather Briefings to Flight Surgeons School, Ft. Rucker, Alabama, October 1986.

Murray P. Hamlet, D.V.M. Cold Weather Training, Ft. Campbell, Louisville, KY, October 1986.

Murray P. Hamlet, D.V.M. Prevention of Cold Injuries, Ft. Drum, NY, November 1986.

Mark W. Sharp, SSG. Infrared Thermography, MG Rapmund, CDR, USAMRDC, USARIEM, Natick, MA, June 1986.

Mark W. Sharp, SSG. Infrared Thermography, MG Ning-Qing Chen, Director, Academy of Military Medical Science, Peoples Republic of China, December 1986, USARIEM, Natick, MA.

Richard Foutch, MAJ. USARIEM's Cold Research Division Alaska Mission, BG Harold Fields, Assistant Division Commander-Maneuver, 6th Infantry Division, (Light), Ft. Wainwright, AK, October 1986.

COLD RESEARCH DIVISION

KEY BRIEFINGS:

Richard Foutch, MAJ. Accidental Hypothermia--An Overview and Mountain Sickness--A Field Emergency, Grand Rounds at the Department of Emergency Medicine, Madigan Army Medical Center, Tacoma, WA, October 1986

Richard Foutch, MAJ. Cold Weather Medical Problems in Alaska, USARIEM Seminar, Natick, MA, November 1986.

Richard Foutch, MAJ. Cold Weather Injuries, Combat Aviation Brigade, Ft. Wainwright, AK, November 1986.

Richard Foutch, MAJ. Organization and Management of Medical Care in a Disaster, Continuing Medical Education Lecture, Interior Regions Emergency Medical Services, Fairbanks, AK, December 1986.

SIGNIFICANT TDY:

Murray P. Hamlet, D.V.M. To participate in Turkish cold weather exercise to determine the utilization of clothing ensemble and training procedures that impact on cold injury prevention, Ankara, Turkey, February 1986.

Murray P. Hamlet, D.V.M. To participate in a cold weather conference, Ft. Monroe, VA, April 1986.

Murray P. Hamlet, D.V.M. To sit on an Office of Naval Research Life Sciences Panel, ONR, Bethesda, MD, April 1986.

Murray P. Hamlet, D.V.M. To participate in a Scientific Review on Cold Weather Medicine, Uniformed Services Section Meeting of the Society of Critical Care Medicine, Wash, DC, May 1986.

Murray P. Hamlet, D.V.M. To participate in Cold Research Program Planning Meeting, Naval Medical Research Laboratory, Bethesda, MD, June 1986.

Murray P. Hamlet, D.V.M. To evaluate and assess emergency medical care, Buenos Aires, Argentina, November 1986.

Ronald Jackson, CPT; Donald E. Roberts, Ph.D.; Mark W. Sharp, SSG; and Janet Fay, SP4. To conduct a field study at Blanchfield Army Hospital to investigate ethnic differences in hand cooling, Ft. Campbell, KY, July 1986.

COLD RESEARCH DIVISION

SIGNIFICANT TDY:

Donald E. Roberts, Ph.D.; George R. Silver, CPT; Diane Engell, Ph.D. (SATD), David L. Moore, SSG; Donald W. Kerr, SSG; Mark W. Sharp; SP5; and William S. Scott, PVT. To collect field feeding and hydration data from elements of Bravo CO, 1st BN, 409th IF during winter operations, Camp Ripley, MN, January-February 1986.

Donald E. Roberts, Ph.D.; David L. Moore, SSG; and Donald W. Kerr, SSG. To start data collection for the use of Classical Conditioning as treatment for relief of cold intolerance following cold injury. This study used subjects at the Blanchfield Army Hospital, Ft. Campbell, KY, November 1986.

Richard Foutch, MAJ. To attend the USAF Arctic Survival Training Course, Eielson Air Force Base, AK, January 1986.

Richard Foutch, MAJ. To attend the Cold Weather Medical Materiel Discussion at the U.S. Army Medical Bioengineering Research and Development Laboratory, Ft. Detrick, MD, January 1986.

Richard Foutch, MAJ. To attend the Cold Weather Medicine course at the Marine Corps Mountain Warfare Training Center, Bridgeport, CA, March-April 1986.

SIGNIFICANT VISITORS:

Commander K. B. Mercx, Commandant Royal Netherlands, Marine Corps, Rotherdam, Netherlands, Cold Injury Specialist.

HEAT RESEARCH DIVISION

SIGNIFICANT RESEARCH FINDINGS/DEVELOPMENTS

We have developed methodology to measure in rats, simultaneously, fluid redistribution among the major compartments during moderate and severe hypohydration. Total body water (TBW) was determined using tritiated water, extracellular fluid volume (ECF) was measured using a single injection C^{-14} insulin technique, and plasma volume (PV) was determined by cardio-green dye dilution. Moderate (10% decrease in body weight) and severe (15%) hypohydration resulted in significant losses in TBW, ECF and PV. Plasma volume was decreased by approximately 25% in both groups, and other fluid compartments were differentially affected. For example, the moderately dehydrated group maintained PV by shifting fluid from the ECF and ISF (interstitial fluid) compartment while preserving the ICF (intracellular fluid). Conversely, the severely dehydrated group maintained PV by re-distributing fluid from both the ECF and ICF compartments. The data indicated that the initial response to fluid loss was the movement of fluid from the ECF pool to sustain both PV and ICF. In severely hypohydrated rats, PV was maintained at the expense of ICF. These experiments indicated that PV and ICF were maximally protected, probably to preserve the integrity of the cardiovascular system and to minimize organ injury.

We have recently reported that acute intraperitoneal administration of pyridostigmine bromide to rats resulted in significant decrements in physical performance in the heat, adverse thermoregulatory effects, and exacerbated elevations in several indices of heat/exercise injury. Since it will be consumed orally as a prophylaxis for organophosphate poisoning, pyridostigmine was dissolved in the drinking water of rats. Consumption of pyridostigimine for 7 days (n=34, 6.6 mg/day) resulted in a 23% ($p<0.001$) reduction of circulating cholinesterase when compared with a control group (n=31) while ingestion for 14 days (n=35, 8.9 mg/day) elicited a 39% ($p<0.001$) inhibition of circulating cholinesterase when compared to a second group (n=33). Water and food consumption, rate of weight gain, and overt behavior were unaffected by pyridostigmine consumption. When approximately half the animals in each group were exercised (9.14 m/min) in the heat (35°C) to hyperthermic exhaustion (Tre=42.51-43°C, rats unable to right themselves), pyridostigmine consumption for 14 days effected a significantly ($p<0.05$) increased rate of weight loss, but no further effects on thermoregulation or performance were noted. Several minor increments were observed in clinical indices of heat/exercise injury in rats consuming pyridostigmine for 14 days. These data indicate that oral dosages of pyridostigmine can probably be titrated to levels of cholinesterase inhibition which are efficacious in prophylaxis against organophosphate toxicity without significant effects on selected physiologic and metabolic processes.

HEAT RESEARCH DIVISION

SIGNIFICANT RESEARCH FINDINGS/DEVELOPMENTS

To determine the effects of dietary manipulation on the metabolic, physical, and physiological exercise in the heat, adult male rats (n=16/group) were food deprived for 72 h followed by ad lib consumption of a high protein (HIPROT) or high carbohydrate (HICARB) diet for 96 h. Each dietary regimen was followed immediately by exercise (9.14 $m \cdot min^{-1}$) in the heat (35°C) to hyperthermic exhaustion (Tco ~ 43°C). Animals consuming the HICARB or HIPROT diet had an increased mean Tco prior to the acute heat/exercise protocol when compared with a control (CONT) group with uninterrupted access to a normal rodent diet; the HICARB rats also manifested a decreased endurance when compared with the CONT group. Plasma levels of urea nitrogen, lactate, and potassium were increased following exercise in the heat in all groups, but greatly exacerbated increments in urea nitrogen occurred in the HIPROT group. Following exercise, significant increments occurred in circulating levels of glucose and insulin in the HIPROT and HICARB groups. Plasma triglycerides were decreased by the exercise/heat regimen but increased by both diets. Thus, these dietary manipulations elicited a variety of metabolic responses which did not markedly alter the physiological and physical effects of work in the heat.

The effectiveness and safety of self-paced heat acclimation procedures (SPHA) was evaluated, using 14 human males exercising 100 min per day for 8 days, at 106.1°F/39% rh. Heat tolerance improved as a result of SPHA, indicated by heart rate, rectal temperature, skin temperature and plasma volume losses. Although SPHA procedures offer many advantages which are not available in conventional training programs (i.e. frequent rest periods, self-selection of exercise intensity), SPHA is not an absolute safeguard against soldiers exceeding heart rate or rectal temperature limits (180 beats/min, 39.5°C). Close medical monitoring of subjects is advisable.

When rats (500g, male) are exercised on a treadmill, pretreatment with the carbamate physostigmine reduces endurance capacity (run time, RT) and increases the rate of rise of core temperature (heating rate, HR). Because physostigmine is a potential nerve agent pretreatment drug, our objective was to determine whether pharmacological intervention could reverse these decrements in performance and thermoregulation. The following drugs were administered separately via tail vein: vehicle-control (C), atropine (200 ug/kg, A), diazepam (500 ug/kg, D), and physostigmine (200 ug/kg, PH). After drug administration, rats were run (11 m/min, 6° elevation, Ta = 26°C) to exhaustion. PH administration resulted in reduced RT (41 min PH vs 53 min C, $p<.05$) with greater HR (0.090°C/min PH vs 0.057°C/min C, $p<.01$) than control rats. However, when A and D were also given to PH treated rats, the RT and HR were restored to control levels. Further, A and D without PH improved RT and HR (82

HEAT RESEARCH DIVISION

SIGNIFICANT RESEARCH FINDINGS/DEVELOPMENTS

min, 0.047°C/min) over control levels. Serial administration of an anticholinergic, an anticonvulsant, and an anticholinesterase resulted in no significant change in performance from control levels.

Because of high sweat rates and difficulty drinking, dehydration may be a significant problem when impermeable chemical protective gear must be worn. The effect of wearing the M17A1 face mask on fluid consumption during a simulated desert (40°C, 30%RH) march was studied in seven (7) male military volunteers. Subjects dressed in shorts, socks, sneakers, webb belt, canteen and face mask walked on a treadmill set at 3mph at 5% grade for 30 min of each hr for 5 hours. On one day, subjects used the current system (CS) and on the second day, the hand-pumped, water delivery system (FF). When walking intermittently in the heat, soldiers consumed significantly less water (0.73 $\pm$ 0.22L) during work periods when wearing the M17A1 mask and using CS than when unmasked and unrestricted (control group 1.29 $\pm$ 0.09L). This deficit in intake was lessened when the FF system (1.20 $\pm$ 0.23L) was used. Five out of 7 troops drank more water when wearing the mask and using FF compared to using CS. Additionally, soldiers using FF consumed 60% of their total intake during the work periods which was similar to the control group. Rest periods which allow adequate time to drink should be provided when using the CS.

Strenuous physical activity in a hot environment may lead to debilitating heat injury such as heat exhaustion or heat stroke. The circulatory responses to hyperthermia are not well documented since prompt treatment precludes data collection in human heatstroke victims. We examined circulatory function in the anesthetized rat model during hyperthermia (T ambient = 42°C). Blood pressure (BP) initially dropped and heart rate (HR) remained unchanged as the animals thermoregulated. With increasing heat stress, cardiac output (CO) and BP rose to attain maximal values at core temperatures of 42°C after which precipitous drops in CO and BP occurred. Increases in both HR and stroke volume contributed to the elevation in CO. The abrupt and significant decrements in CO and HR may be an indication of ensuing cardiac failure.

In hot regions, soldier performance limits and drinking water requirements become factors in mission planning and tactical options. Although existing hot weather doctrine and more sophisticated computer models can accurately determine requirements/constraints for soldier performance under any given set of environmental conditions, there is presently no integrated weather data acquisition/processing/communications system to support archival or near-real-time assessments of specific hot regions, world-wide. In order to directly

HEAT RESEARCH DIVISION

SIGNIFICANT RESEARCH FINDINGS/DEVELOPMENTS

address weather effects on the human component of the man-weapon system combination, we have developed a computer algorithm to extract WBGT (Wet Bulb-Globe Temperature) Index information from the standard weather data sets collected and archived by the U.S. Air Force Environmental Technical Applications Center (ETAC). This information can be used to to provide 24 profiles of (a) hourly drinking water costs (b) optimal work/rest cycles and (c) tolerance time in MOPP. Performance of the algorithm was tested during Operation Bright Star 85 and precision on the order of $\pm$ 2°F for predicted vs measured WBGT were obtained. Current efforts include development of a cloudy sky capability for the algorithm and an evaluation of remote sensing technologies to support comprehensive geographic coverage for heat injury prevention products/tactical decision aids.

PUBLICATIONS

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Durkot, M., R. Francesconi and R. Hubbard. Effect of age, weight and metabolic rate on endurance, hyperthermia and heatstroke mortality in a small animal model. Aviat.Space Environ. Med. 57:974-979, 1986.

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ABSTRACTS

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Szlyk, P.C., I.V. Sils, J.D. Ferguson, and R.W. Hubbard. Circulatory responses to hyperthermia in the anesthetized rat. The Physiologist 29:115, 1986.

PRESENTATIONS

Armstrong, L., R. Hubbard, J. DeLuca, and E. Christensen. Heat exhaustion syptomatology during high intensity exercise. The American College of Sports Medicine Regional Meeting, Boxborough, MA 1986.

KEY BRIEFINGS

Lawrence E. Armstrong, CPT, Ph.D. Dehydration, exercise, and prevention of heat injury in the reserve component. 122d Army Reserve Command, San Antonio, TX, March 1986.

Lawrence E. Armstrong, CPT, Ph.D. Running in the heat. American Medical Joggers Association, Annual Meeting, Boston, MA, April 1986.

Lawrence E. Armstrong, CPT, Ph.D. High and dry: Can we avoid high body temperature and dehydration on the run? Wright State University Seminar, Total Fitness Lifestyle Division, Dayton, OH, April 1986.

Lawrence E. Armstrong, CPT, Ph.D. Desert living and heat casualties. 351st General Hospital, U.S. Army Reserve, Hanscom Air Force Base, Bedford, MA, May 1986.

HEAT RESEARCH DIVISION

KEY BRIEFINGS

Lawrence E. Armstrong, CPT, Ph.D. Lessons from the desert: Performance during salt &/or water imbalance. Current Concepts in Environmental Medicine Course, USARIEM, Natick, MA, May 1986.

Lawrence E. Armstrong, CPT, Ph.D. Heat Stroke and the EMT. Paramedic Services Division, Marlborough Hospital, Marlborough, MA, June 1986.

Lawrence E. Armstrong, CPT, Ph.D. Recent research findings: Heat Research Division, USARIEM. Physicians Seminar Series, Cutler Army Hospital, Ayer, MA, June 1986.

Lawrence E. Armstrong, CPT, Ph.D. Heat injury research for the clinician. Physicians Seminar, U.S. Army Hospital, West Point Military Academy, West Point, NY, July 1986.

Lawrence E. Armstrong, CPT, Ph.D. Preventive medicine aspects of heat illness. Epidemiology of non-infectious diseases course, F.E. Herbert School of Medicine, Bethesda, MD, July 1986.

Lawrence E. Armstrong, CPT, Ph.D. Heat illness: Considerations for the flight surgeon. Aeromedical Center, Ft. Benning, Columbus, GA. March and September 1986.

Lawrence E. Armstrong, CPT, Ph.D. Water intake in protective clothing: Investigation of two water delivery systems. Water Resources Management Action Group, Ft. Belvoir, Alexandria, VA, September 1986.

Ralph P. Francesconi, Ph.D. Desert operations and the prevention of heat injury, U.S. Army Reserve Physicians, University of Vermont, Burlington, VT, April 1986.

Ralph P. Francesconi, Ph.D. Prevention of heat injury. Global Medicine Course, USAF School of Aerospace Medicine, San Antonio, TX, April 1986.

Ralph P. Francesconi, Ph.D. Prevention of heat injury. 101st Airborne Division (6 Briefings). Ft. Campbell, KY, June 1986.

Roger W. Hubbard, Ph.D. Water as a Tactical Weapon. American Academy of Environmental Engineers and American Water Works Association Meeting, Denver, CO, June 1986.

Roger W. Hubbard, Ph.D. Prevention, diagnosis and treatment of heat illness. HQ Third United States Army, Ft. McPherson, Atlanta, GA, October 1986.

HEAT RESEARCH DIVISION

KEY BRIEFINGS

William T. Matthew. Feasibility of extracting WBGT index from U.S.A.F. weather network data: Bright Star 85 Tests. Water Resources Management Action Group. Fort Belvoir, Alexandria, VA, September 1986.

Patricia C. Szlyk, Ph.D. Recognition and treatment of chemical/nerve agent casualties. 373rd General Hospital, Boston, MA, January 1986.

Patricia C. Szlyk, Ph.D. Heat Injury: Diagnosis, treatment and prevention. USARIEM Current Concepts in Environmental Medicine Course, Natick, MA, May 1986.

SIGNIFICANT TDY

Roger W. Hubbard, Ph.D. Outside protocol reviewer. Robert Taft Laboratory, NIOSH, Cincinatti, OH, 9-10 April, 1986.

Roger W. Hubbard, Ph.D. DOD Steering Committee on Field Water Quality, Ft. Detrick, Frederick, MD, 23-24 April, 1986.

Roger W. Hubbard, Ph.D. WRMAG Taskings, Pentagon, Wash DC, 3 September 1986.

Roger W. Hubbard, Ph.D. WRMAG 10, Ft. Belvoir, VA, 16 September 1986.

Roger W. Hubbard, Ph.D. DCSLOG Water Office, Pentagon, Wash DC, 10 December, 1986.

William T. Matthew and SGT Glenn J. Thomas, 16 day MRE test, Hawaii, 14-29 October, 1986.

PROFESSIONAL APPOINTMENTS/ACTIVITIES

Lawrence E. Armstrong, CPT, Ph.D. Fellow, American College of Sports Medicine.

Lawrence E. Armstrong, CPT, Ph.D. Steering Committee of Journal Applied Sports Science Research.

Lawrence E. Armstrong, CPT, Ph.D. Aerospace Medical Association's Environmental Science Award, presented annually to senior author of best environmental science paper in Aviat. Space Environ. Med. Sponsor: McDonell Douglas Corp. Nashville, TN, 1986.

HEAT RESEARCH DIVISION

PROFESSIONAL APPOINTMENTS/ACTIVITIES

Lawrence E. Armstrong, CPT, Ph.D. Contracting Officer's Representative DAMD17-86-C-6087, Tuskeegee University, AL.

Lawrence E. Armstrong, CPT, Ph.D Reviewer, National Strength and Conditioning Association Journal; Aviation, Space and Environmental Medicine; International Journal of Sports Medicine; and Physician and Sportsmedicine.

Michael J. Durkot, Ph.D. Guest reviewer - Aviation, Space and Environmental Medicine.

Ralph P. Francesconi, Ph.D. Chairman, Laboratory Animal Care and Use Committee, USARIEM.

Ralph P. Francesconi, Ph.D. Advisor, NAS/NRC Associateship Program, USARIEM.

Ralph P. Francesconi, Ph.D. Member, Quality Assurance Formulation Committee, USARIEM.

Ralph P. Francesconi, Ph.D. Reviewer, Aviation Space and Environmental Medicine.

Ralph P. Francesconi, Ph.D. Contracting Officer's Representative DAMD17-85-C-5099, Purdue University.

Ralph P. Francesconi, Ph.D. Reviewer, American Physiological Society, Journal of Applied Physiology.

Roger W. Hubbard, Ph.D. Adjunct Associate Professor of Pathology, Boston University School of Medicine.

Roger W. Hubbard, Ph.D. Water Resources Management Action Group. DCSLOG.

Roger W. Hubbard, Ph.D. DoD Steering Committee for Field Water Quality.

Roger W. Hubbard, Ph.D. Guest reviewer. American Journal of Physiology and Aviation Space and Environmental Medicine.

Roger W. Hubbard, Ph.D. Contracting Officer's Representative for DAMD17-86-C-6167, Boston University.

Candace Matthew. Member, Aerospace Medical Association.

HEAT RESEARCH DIVISION

PROFESSIONAL APPOINTMENTS/ACTIVITIES

Patricia C. Szlyk, Ph.D. Biochemist, 373rd General Hospital, US Army Reserve, Boston, MA.

Patricia C. Szlyk, Ph.D. Reviewer for National Strength Conditioning Association.

Patricia C. Szlyk, Ph.D. Contracting Officer's Technical Representative, Institute of Chemical Defense.

EXERCISE PHYSIOLOGY DIVISION

SIGNIFICANT RESEARCH FINDINGS/DEVELOPMENTS:

The results from a study investigating the impact of continuous operations on the physical fitness capacity and performance of field artillery guncrews showed that soldiers allowed 5 hours sleep per day displayed no decrements in physical fitness capacity or evidence of physical fatigue for up to 8 days of operations.

When setting exercise intensity or minimal oxygen uptake requirements for a non-traditional type of exercise (i.e., repetitive lifting) it is inaccurate to base the intensity on a percentage of $\dot{V}O_2max$ determined while treadmill running or other traditional forms of exercise testing.

Based on data collected at Ft. Jackson in 1984, the crude risks of injury for female Army basic trainees are about twice those for male trainees (50.5% vs 27.5%). Low levels of entry level physical fitness are associated with greater risks of musculoskeletal injuries for both male and female trainees. Male Army trainees running mile times in the slowest 2 quartiles were at 2.5 times the risk or injury as those running in the fastest 2 quartiles (33% vs 13%), while for females the slowest group was at 1.6 times the risk of the fastest (57% vs 35%). Also, for males those individuals who professed to be inactive prior to joining the Army were at 1.8 times the risk of those who were active (36.4% vs 22.5%). There was a marginal association between muscle endurance as measured by push-ups and likelihood of injury. Also, it appeared that male trainees over the age of 23 were at greater risk of injury, but it should be noted that they exhibited lower levels of fitness and higher percents of body fat compared to their younger counterparts.

A trial of the efficacy of a shock absorbing viscoelastic polymer insole in preventing bone stress fractures and other lower extremity injuries was conducted in 3032 Marine recruits during their 12 week basic training. The insoles had no protective effect on these overuse injuries.

A method was developed to predict time to exhaustion during exercise performed at known percentages of maximal power. Test scores are produced which describe both an individual's ability to exert maximal power and his/her ability to sustain power output at submaximal levels. Maximal leg power is higher, and maximal power output lower at higher movement speed. Thigh muscle cross sectional area, estimated from simple measurements, is a better predictor of maximal force and power than are body mass and lean body mass.

EXERCISE PHYSIOLOGY DIVISION

PUBLICATIONS:

Duggan, A. and J.F. Patton. Oxygen cost of performing a running test in boots: Assessments on road and treadmill. APRE Memorandum, 86M511. Army Personnel Research Establishment, US. 1986.

Evans, W.J., J.G. Meredith, C.A. Cannon, W.R. Dinarello, V.A. Frontera, V.A. Hughes, B.H. Jones, H.G. Knuttgen. Metabolic change following eccentric exercise in trained and untrained men. J. Appl. Physiol. 61:1864-1868, 1986.

Fitzgerald, P.I., J.J. Knapik, W.L. Daniels, J.A. Vogel, B.E. Joyce. Influence of atropine on physical performance in the heat. USARIEM Technical Report T/16, 1986, May 1986.

Jones, B.H., W. Daniels, M. Toner, J. Knapik. Energy cost of women walking and running in shoes and boots. Ergonomics. 29:439-443, 1986.

Fitzgerald, P.I., J.A. Vogel, W.L. Daniels, J.E. Dziados, M.A. Teves, R.P. Mello and P.J. Reich. The body composition project: a summary report and descriptive data. USARIEM Technical Report T/5, 1987, Dec. 1986.

Mello, R.P., J.A. Vogel, J.F. Patton III, and B.H. Jones. Assessment of physical activity intensity during infantry combat-simulated operations. USARIEM Technical Report No. T/4, 1987, Dec, 1986.

Murphy, M.M., J.F. Patton and F.A. Frederick. Comparative anaerobic power of men and women. Aviat. Space Environ. Med. 57:636-641, 1986.

Patton, J.F., J.A. Vogel, J. Bedynek, D. Alexander and R. Albright. Aerobic capacity and coronary risk factors in a middle-aged Army population. J. Cardio-pulmonary Rehab. 6:491-498, 1986.

Teves, M.A., J.A. Vogel, D.E. Carlson and D.D. Schnakenberg. Body composition and muscle performance aspects of the 1985 CFFS test. USARIEM Technical Report No. T/12, 1986.

Vogel, J.A., J.F. Patton, R.P. Mello and W.L. Daniels. An analysis of aerobic capacity in a large United States population. J. Appl. Physiol. 60:494-500, 1986.

EXERCISE PHYSIOLOGY DIVISION

ABSTRACTS:

Dziados, J., S. Norton, B.H. Jones, J. Harris. Epidemiology of training injuries in Army trainees. Med. Sci. Sport. Exerc. 18:S 10, 1986.

Frykman, P.N., E.A. Harman, W.J. Kraemer, and E. Clagett. Intra-abdominal and intra-thoracic pressures during intense physical activities. Med Sci. Sport. Exerc. 18:S 63, 1986.

Isaac, N., B.H. Jones, M. Teves, J. Dziados, T. Cusson. Effects of age on risks of casualties of marathons. Med Sci. Sport. Exerc. 18:S 95-96, 1986.

Jones, B.H., J. Harris, T. Ewart, S. Norton, J. Vogel. Fitness and Sex: Risk factors for injury, illness, and discharge from the Army. Am. Public Health Association annual meeting. Local Health Services: Crisis on the front line, Abstracts p 21, 1986.

Jones, B.H., M. Maclure, P. Rock, W. Daniels, J. Casey, M. Adner. Effect of heat on risk of casualties at the Boston Marathon. Med. Sci. Sport. Exerc. 18:S 74, 1986.

O'Reilly, K., M. Worhal, C. Meredith, W. Frontera, R. Fielding, J. Patton and W. Evans. Immediate and delayed ultrastructural changes in skeletal muscle following eccentric exercise. Med. Sci. Sports Exerc. 18:542, 1986.

Patton, J.F., J.E. Wright, and J.A. Vogel. Comparison of aerobic and anaerobic power during upper and lower body exercise. Fed. Proc. 45:645, 1986.

Rubin, C.T., J.M. Harris, D. Sweet, B. Jones, L.E. Lanyon. Stress Fractures: An Alternative Etiology. Transactions of European Soc of Biomech Research, 5th meeting. p 230, 1986.

PRESENTATIONS:

Harman, E. Exercise endurance time as a function of percent maximal power production. American Physiological Society, New England Annual Meeting, N. Grafton, MA, September 1986.

Harman, E. Maximal cycling force and power at 40 and 100 RPM, National Strength and Conditioning Association Annual Meeting, New Orleans, June 1986.

Harman, E. Symposium lecture: Biomechanics of Specificity. National Strength and Conditioning Association Annual Meeting, New Orleans, June 1986.

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EXERCISE PHYSIOLOGY DIVISION

PRESENTATIONS:

Jones, B.H The risks of injury resulting from physical activity. Society for Epidemiologic Research. Invitational lecture at annual meeting, Pittsburg, PA, June 1986.

Jones, B.H. Marathon injuries: the Boston Experience. Boston Marathon Medical Symposium, Boston, MA, April 1986.

Jones, B.H. Risk factors for physical training injuries. U.S. Army Preventive Medicine Symposium. Washington, DC, May 1986.

Jones, B.H. Risk factors for musculoskeletal injuries. U.S. Army Physical Fitness Facilitator course. Ft. Sam Houston, TX, 17 September 1986.

Jones, B.H. Risk factors for injuries associated with Army physical training. Grand Rounds MEDDAC, Ft. Benning, Ga, November 1986.

Jones, B.H. Epidemiology of Marathon Injuries. International Marathon Medical Directors Meeting. New York Marathon, NY, October 1986.

Kraemer, W., L. Marchitelli, D. McCurry, S. Fleck, J. Dziados, E. Harman, P. Frykman and A. Vela. Lactate responses to different resistance exercise protocols, NSCA Annual Meeting, New Orleans, May 1986.

Mello, R.P., J.A. Vogel, J.F. Patton III, and B.H. Jones. Physical intensity during a five day infantry sustained combat operation. Walter Reed Army Institute of Research Conference, Washington, D.C., Aug, 1986.

Teves, M.A., J.M. McGrath, J.J. Knapik and S.J. Legg. An ergometer for maximal effort repetitive lifting. Proceedings of the Eighth Annual Conference of the IEEE/Engineering in Medicine and Biology Society, Fort Worth, TX, Nov. 1986.

KEY BRIEFINGS:

Bruce H. Jones, MAJ, M.D., M.P.H. Risks for injury associated with Army training and study proposal. Separate briefings to: COL Richards, MEDDAC Commander, U.S. Army Infantry Training Center, LTC Rusin, Deputy Commander, LTC Rusin, Reception Station Commander, Ft. Benning, GA, November 1986.

Bruce H. Jones, MAJ, M.D., M.P.H. Risk factors for injury associated with Army basic training. LTC Lam of USAMRDC, at USARIEM, Natick, MA., October 1986.

EXERCISE PHYSIOLOGY DIVISION

KEY BRIEFINGS:

Bruce H. Jones, MAJ, M.D., M.P.H. Risk factors for injuries associated with physical training injuries in Army populations and proposals for future study of injury epidemiology. LTG Becker, Surgeon General of U.S. Army, LTG Becker, OTSG, Falls Church, VA, June 1986.

James A. Vogel, Ph.D. Physical performance research program. U.S. Army War College, Carlisle Barracks, PA., April 1986.

SIGNIFICANT TDY:

Vogel, J.A., J.F. Patton, E. Harman and M. Sharp. Field artillery sustained operations study, Ft. Sill, OK. May - June 1986.

Mello, R.P., J.A. Vogel, and K. Reynolds. Load carriage field study, Aberdeen Proving Ground, MD. October 1986.

Vogel, J.. Participated in DOD HFE Sub Technical Advisory Group meeting on Sustained/Continuous Operations. Cocoa Beach, FL, 6-7 May 1986.

Mello, R.P., and A. Damokosh. Participated in DOD HFE Sub Technical Advisory Group Symposium on Sustained/Continuous Operations. Wash, DC, 21-22 Aug 1986.

PROFESSIONAL APPOINTMENTS/ACTIVITIES:

Vogel, J.A. Adjunct Associate Professor, Boston University, Boston, MA.

Vogel, J.A. Corresponding Editor, International Journal of Sports Medicine.

Vogel, J.A. Member, Army Surgeon General Task Force on Physical Fitness.

HEALTH AND PERFORMANCE DIVISION

SIGNIFICANT RESEARCH FINDINGS/DEVELOPMENTS:

A symposium was conducted to describe and evaluate new methods for performance assessment. Specific methods to evaluate the psychometric properties of tests for repeated-measures paradigms and ways to design assessment protocols for specific testing requirements were described. Reasons for why many studies may underestimate treatment effects and why the performance literature has many apparent contradictions were presented. Other presentations showed the utility of symptom and mood measures for assessing the effects of high altitude, treatment strategies for high altitude, and sustained operations in soldiers wearing the MOPP uniform. Data for cognitive performance in various special environments (and after a pharmacological treatment strategy) illustrated some of the methodologies described in the symposium.

Data from our previous studies of environmental stressors were collated for a meta-analysis. Originally, various measures of cognitive performance were investigated experimentally in repeated-measures paradigms for several high altitudes, an altitude-treatment strategy, dehydration, cold, and atropine in a hot environment. Each stressor impaired cognitive performance on most tasks. Recovery of performance during 2 days at 4600 m depended upon the task; not all tasks improved fully. Impairments were usually due to decreases in the rate of performance rather than increased errors, e.g. problem solving rates decreased linearly from 4500-7600 m (15,000 - 25,000 ft) high altitude during a 40-day progressive exposure. These results suggest even well-practiced and overlearned tasks deteriorate with various environmental stressors.

To explore characteristics of performance impairments, e.g. output-accuracy tradeoffs and individual performance styles, we analyzed cognitive performance decrements from six of our previous studies of environmental stressors (heat and atropine, dehydration, cold, and high altitude). Performance impairments were encountered for all stressors on most tasks but some recovered with continued exposure. Impairments were due to a slowing of performance rather than increased errors. Performances on spatial tasks requiring intuition was negatively correlated with baseline performances in stressful environments. (Subjects with impaired performances during the stressor had higher baselines before the challenge). These findings suggest that strategies such as special training or job design may reduce the impact of adverse environments upon work tasks.

HEALTH AND PERFORMANCE DIVISION

SIGNIFICANT RESEARCH FINDINGS/DEVELOPMENTS:

We examined the effects of heat on the sustained cognitive performance of sedentary soldiers clad in chemical protective clothing. Twenty male soldiers (two groups of four and two groups of six) trained for two weeks on tasks resembling those performed by fire direction center, forward observer and communications personnel. Then, they performed the tasks for seven-hour periods on four successive days in hot (91°F, 61% RH) and normal (70°F, 35% RH or 55°F, 35% RH conditions, with and without protective clothing (MOPP IV). The data indicated quite conclusively that after four to five hours of exposure to a moderately hot environment, the cognitive performance of a group of highly trained soldiers, clad in the MOPP IV configuration of the chemical protective suit, began to deteriorate markedly. By the end of seven hours of exposure to heat, increases in percent group error on investigator-paced tasks ranged from 17% to 23% over control conditions (BDU; 70°F, 35% RH). Virtually all of this decrement was due to increases in errors of omission. The productivity of the group on a self-paced task (map plotting with range and deflection determinations) diminished by approximately 40% from control conditions after six hours in the heat, but accuracy did not appear to be markedly affected. Two individuals became heat casualties and had to be evacuated from the chamber for medical reasons. A significant number of personnel had the integrity of their protective clothing compromised by sweat after as little as three hours of exposure to heat and virtually no physical activity.

A study was conducted to examine the influence of soldiers' attitudes toward the cold, expectations concerning living and working in the cold, and subjective reports of psychological stress on subsequent symptoms of physical illness and psychological mood during military training in the cold. Fifty-nine male soldiers were followed during eight days of winter training on military tactics conducted by the Army National Guard's Mountaineering School in northern Vermont. The results of this study suggests that a subgroup of individuals may be identified in advance of cold weather training who are likely to display symptoms of negative mood (tension, depression, anger, and confusion) and symptoms of poor physical well-being (fatigue, muscle discomfort, and nasal discomfort) when they are undergoing cold weather training. These individuals are likely to have more stress in their everyday lives, are likely to expect that they will dislike living in the cold, or both.

A study was conducted to evaluate the separate and combined effects on manual dexterity of wearing both the butyl rubber gloves and the M17A1 gas

HEALTH AND PERFORMANCE DIVISION

SIGNIFICANT RESEARCH FINDINGS/DEVELOPMENTS:

mask with hood. The results of this study indicated that compared to bare-handed conditions, manual dexterity (as measured by the O'Connor Fine Finger Dexterity Test and the Purdue Pegboard Assembly Test) was substantially poorer when the soldier wore gloves. However, the differences in performance between bare-handed and gloved conditions remained the same regardless of whether or not the soldier was wearing the gas mask with the hood. That is, the gas mask with hood did not restrict vision enough to impair manual dexterity. It was also found that learning of the manual tasks was slower under the gloved conditions. If soldiers are expected to perform proficiently while in chemical protective clothing, they should be given more than a familiarization with the wearing of the clothing. They should be given intensive training in job-specific tasks while wearing the chemical protective clothing. This training is especially important if the job-specific tasks require an appreciable amount of manual dexterity.

Visual contrast sensitivity is a measure of the ability to visually distinguish subtle differences in shades of gray, which are not reflected by visual acuity tests, since the latter are based on black-white high contrast relationships at high luminance. Since hypoxia affects brightness discrimination, it is feasible that tests such as contrast sensitivity could be affected at altitude, unlike visual acuity tests which have shown no such effect. Contrast sensitivity thresholds were studied over 40 days during gradual ascent to an altitude of 25,000 ft in a decompression chamber. Only ambient pressure, and thus inspired oxygen pressure, was varied, thereby eliminating many of the confounding effects of cold, dehydration, malnutrition and exhaustion, commonly encountered on very high mountains. Contrast sensitivity thresholds measured by the Ginsburgh Vistech test showed no overall impairment as altitude increased. These results are different from those of other previously reported vision studies involving shorter exposures, lower altitudes and lower test luminances. The results can be explained on the basis of the higher stimulus luminances used to test contrast sensitivity. Compared to the stimulus luminances used in visual tests previously reported in the literature, these higher luminance levels would be less likely to be affected by hypoxia.

PUBLICATIONS:

Banderet, L.E. Symposium: Assessing the effects of environmental stressors and treatment strategies. Proc. Military Testing Assoc., pp. 568-597, 1986.

HEALTH AND PERFORMANCE DIVISION

PUBLICATIONS:

Banderet, L.E., K.P. Benson and D.M. MacDougall. Development of cognitive tests for repeated performance assessment. USARIEM Technical Report No. T/17, 1986.

Banderet, L.E., D.M. MacDougall, D.E. Roberts, D. Tappan, M. Jacey and P. Gray. Effects of hypohydration or cold exposure and restricted fluid intake on cognitive performance. In: Predicting Decrements in Military Performance Due to Inadequate Nutrition. Washington, DC., National Academy Press, pp. 69-79, 1986.

Banderet, L.E., D.M. MacDougall, D.E. Roberts, D. Tappan, M. Jacey and P. Gray. Effects of hypohydration or cold exposure and restricted fluid intake on cognitive performance. USARIEM Technical Report No. T/15, 1986.

Banderet, L.E., B.L. Shukitt, B.A. Crohn, R.L. Burse, D.E. Roberts and A. Cymerman. Characteristics of cognitive performance in stressful environments. Proc. Military Testing Assoc. pp. 425-430, 1986.

Banderet, L.E., B.L. Shukitt, B.A. Crohn, R.L. Burse, D.E. Roberts and A. Cymerman. Effects of various environmental stressors on cognitive performance. Proc. Military Testing Assoc. pp. 592-597, 1986.

Fine, B.J. and J.L. Kobrick. Assessment of the effects of heat and NBC protective clothing on performance of critical military tasks. USARIEM Technical Report No. T/11, 1985 (dated June 1985, but printed and issued in August, 1986).

Fine, B.J. and J.L. Kobrick. Cigarette smoking, field-dependence and contrast sensitivity. Proc. Military Testing Assoc., pp. 401-406, 1986.

Jobe, J.B. and L.E. Banderet. Cognitive testing in military performance research. In: Proc. Workshop on Cognitive Testing Methodologies. National Academy Press, Washington, DC, pp. 181-193, 1986.

Johnson, R.F. and L.A. Sleeper. Effects of chemical protective handwear and headgear on manual dexterity. Proc. Human Factors Society 30th Annual Meeting. pp.994-997, 1986.

HEALTH AND PERFORMANCE DIVISION

PUBLICATIONS:

Kennedy, R.S., N.E. Lane, R.L. Wilkes and L.E. Banderet. Development of behavioral assessment protocols for various repeated-measures testing paradigms. Proc. Military Testing Assoc. pp. 568-573, 1986.

Kobrick, J.L. and L.A. Sleeper. Effect of wearing chemical protective clothing in the heat on signal detection over the visual field. Aviat. Space Environ. Med., 57:144-148, 1986.

Munro, I., T.M. Rauch, W.J. Tharion, L.E. Banderet, A.R. Lussier and B.L. Shukitt. Factors limiting endurance of Armor, Artillery, and Infantry units under simulated NBC conditions. Proc. Army Science Conference: VOL III, p. 85-96, 1986.

Rauch, T.M., L.E. Banderet, W.J. Tharion, I. Munro, A.R. Lussier and B.L. Shukitt. Factors influencing the sustained performance capabilities of 155 mm howitzer sections in simulated conventional and chemical warfare environments. USARIEM Technical Report No. T/11, 1986.

Rauch, T.M., C.E. Witt, L.E. Banderet, R. Tauson and M. Golden. The effects of wearing chemical protective clothing on cognitive problem solving. USARIEM Technical Report No. T/18, 1986.

Schnakenberg, D.D., D. Carlson, M. Sawyers, J. Vogel, R.F. Johnson, P.C. Szlyk, R. Francesconi and R.W. Hubbard. Nutritional evaluation of a new combat field feeding system for the Army. Proc. Army Science Conference. 4:69-80, 1986.

Shukitt, B.L. and L.E. Banderet. Mood states at 1600 and 4300 meters high terrestrial altitude. Proc. Military Testing Assoc. 586-591, 1986.

Tharion, W.J., T.M. Rauch, I. Munro, A.R. Lussier, L.E. Banderet, and B. Shukitt. Psychological factors which limit the advance capabilities of armor crews operating in a simulated NBC environment. USARIEM Technical Report No. T/14, 1986.

PRESENTATIONS:

Banderet, L.E., H.R. Lieberman, R.P. Francesconi, B.L. Shukitt, R.F. Goldman, D.D. Schnakenberg, T.M. Rauch, P.B. Rock and G.F. Meadors, III. Development of a paradigm to assess nutritive and biochemical substances in humans: A preliminary report on the effects of tyrosine upon altitude- and cold-induced stress responses. NATO AGARD Symposium: Biochemical Enhancement of Performance. Lisbon, Portugal, 20 Sept-2 Oct, 1986.

HEALTH AND PERFORMANCE DIVISION

PRESENTATIONS:

Fine, B.J. and J.L. Kobrick. Sustained human performance in the heat: summary of an on-going research program. 10th Annual Psychology in the DOD Symposium, USAF Academy, Colorado Springs, CO, April 1986.

Kobrick, J.L. and R.F. Johnson. Effects of treatment drugs, heat exposure, and NBC protective gear on performance of military tasks by male and female personnel. Poster presentation at the In-Process Review meeting of the Joint Working Group on Drug Dependent Decrements to Military Performance (JWGD3). USAMRDC, Frederick, MD, January, 1986.

Rauch, T.M., I. Munro, W. Tharion and L.E. Banderet. Subjective symptoms, human endurance, and cognitive interventions. Proceedings, Tenth Psychology in the DOD Symposium. Colorado Springs, CO, 1986.

KEY BRIEFINGS:

Johnson, R.F. Effects of thermal stress and chemical protective clothing on speech intelligibility and manual dexterity. Lecture presented at the P^2NBC^2 Symposium, US Army Research Institute of Environmental Medicine, Natick, MA, January 1986.

Johnson, R.F. Sick call, psychological mood, and subjective reports of symptomatology during cold weather operations. Lecture presented at the Vermont Army National Guard Mountaineering School, Jericho, Vermont, January 1986.

Johnson, R.F. Environmental stress, chemical protection, and performance. Lecture presented at the course Current Concepts in Environmental Medicine, US Army Research Institute of Environmental Medicine, Natick, MA, May 1986.

SIGNIFICANT TDY:

Dr. Johnson to cold weather field study at Vermont Army National Guard Mountaineering School, Jericho, Vermont. January-February 1986.

PROFESSIONAL APPOINTMENTS/ACTIVITIES:

Louis E. Banderet, Ph.D., Instructor, Psychology, Newbury Junion College, Boston, MA.

HEALTH AND PERFORMANCE DIVISION

PROFESSIONAL APPOINTMENTS/ACTIVITIES:

Louis E. Banderet, Ph.D., Lecturer, Psychology, Quinsigamond Community College, Worcester, MA.

Louis E. Banderet, Ph.D., Who's Who in the East.

Richard F. Johnson, Ph.D., Editorial Consultant, Exercise and Sport Sciences Reviews.

Richard F. Johnson, Ph.D., Member, Technical Group Advisory Committee, Human Factors Society.

MILITARY ERGONOMICS DIVISION

SIGNIFICANT RESEARCH FINDINGS/DEVELOPMENTS:

A study evaluated the effectiveness of an air-cooled vest in reducing physiological strain of soldiers in chemical protective clothing during exercise-heat stress. Four male soldiers attempted a 12-hour and a 3-hour heat exposure while wearing chemical protective clothing and an air-cooled vest (air supplied to vest = 16°C db, 3°C dp; 15 scfm to torso, 3 scfm to face). During these exposures, subjects performed repeated bouts of rest and treadmill walking: metabolic rate averaged 240 and 340 W for the 12- and 3-hour tests, respectively. Environmental conditions were 49°C db, 20°C dp; a radiant heat load of 70 W was added during the 3-hour test. All subjects were able to complete the 12- and 3-hour tests. Mathematical equations by Givoni and Goldman predicted tolerance times for the 12- and 3-hour tests with no microclimate cooling to be about 110 and 80 min, respectively. During the 12-hour test, final rectal temperature (exercise) averaged 38.0 ± 0.3°C and peak rectal temperature did not exceed 38.5°C for any subject. Final heart rate (exercise) averaged 140 ± 19 $b \cdot min^{-1}$. Sweating rate averaged 275 ± 19 $g \cdot m^{-1}$. During the 3-hour test, final rectal temperature averaged 38.5 ±0.6°C, and peak rectal temperature did not exceed 39.2°C for any subject. Final heart rate (exercise) was 150 ± 15 $b \cdot min^{-1}$. Sweating rate averaged 566 ± 50 $g \cdot m^{-2} \cdot h^{-1}$. The air-cooled vest was effective in reducing physiological strain, and increasing tolerance time, of soldiers during exercise-heat stress. In addition, soldiers rated the heat exposures with the vest as thermally comfortable.

Although optimal microclimate cooling would be provided by cooling the entire body, the space, weight, and power constraints limit cooling to only specific body regions. Currently, the U.S. Army Natick Research, Development and Engineering Center is experimenting with a liquid microclimate cooling garment (MCG) which can be configured in several ways and thereby provide cooling to different body regions. In one configuration, only the torso is cooled. Alternate configurations can provide cooling to both the torso and upper arms; or to the torso, upper arms and upper thighs. Dry heat exchange (radiative and conductive) of different body regions has been shown to be influenced by the type of work (upper versus lower body) being performed, thus the optimal configuration of regional cooling may be different for work employing upper body muscle groups (e.g., loading and firing) as compared to work primarily employing lower body muscle groups (e.g., dismounted repair or resupply operations). During CY86, the effectiveness of the varied configurations of the liquid microclimate cooling garment for alleviation of thermal strain during upper body, as compared to lower body exercise, was evaluated. The results of this investigation indicate that increasing the surface area covered by a conductive microclimate cooling system to include the upper arms

MILITARY ERGONOMICS DIVISION

SIGNIFICANT RESEARCH FINDINGS/DEVELOPMENTS:

imparts no advantage for cooling during upper body exercise in the heat compared with cooling the torso alone. However, during lower body exercise in the heat, smaller changes in core temperature and lower sweat rates are observed when surfaces of the thighs are cooled in addition to the torso surfaces. The difference in the effect of increasing surface area for cooling is due to the small surface area of the arms compared with the thigh or, probably more likely, due to a greater ability of thighs to make vasomotor adjustments to take advantage of increased conductive cooling.

This project was conducted to study the physiological strain of soldiers during exercise-heat stress wearing uniforms made of four different chemical protective fabric systems, viz. the current issue (84) and three experimental fabric systems: Monopak (MO), Bipak (BI), and a material made by Minnesota Mining and Manufacturing Co. (3M). Five heat-acclimated subjects each attempted 12 125-min heat exposures, each exposure on a different day, consisting of 10 min rest followed by four 25-min walks (metabolic rate of about 500W) separated by 5-min rest periods. There were three test environments, all 29.5°C dry bulb but with three combinations of relative humidity and wind speed: 1) 20%, 5 m/s; 2) 20%, 1.1 m/s; and 3) 85%, 5 m/s. In addition, the experimental fabric systems, which are designed to be washed, were all tested again in environment 2 after washing. Indices of physiological strain were heart rate (HR), rectal temperature (T_{re}), mean skin temperature (T_{sk}), and change in rectal temperature since the start of exercise (ΔT_{re}). At the end of the fourth walk, the overall ranking of the uniforms from best to worst in terms of physiological strain was MO, BI, 84, 3M. ΔT_{re} and T_{sk} showed statistically significant differences ($P<0.005$) between fabric systems, but the only significant ($P<0.05$) pairwise comparisons were that MO was better than either 84 or 3M in terms of ΔT_{re} and T_{sk}. HR, absolute T_{re}, and subjects' ratings of thermal sensation, fatigue, and discomfort did not show statistically significant differences ($P>0.05$) among fabric systems. After the uniforms were washed, T_{re}, ΔT_{re}, and T_{sk} in BI were substantially and consistently reduced, although this effect was not quite statistically significant. Washing thereby eliminated most of the difference in physiological strain between BI and MO. The fire retardant treatment of the BI, which does not withstand washing, may account for additional physiological strain in the unwashed uniforms. Based on thermal measurements made on these fabric systems on an aluminum mannikin, the ranking by i_m/I_t, the ratio of water vapor permeability to thermal insulation, is 3M, BI, MO, 84. However, the 3M fabric system has a much lower air permeability than the other fabric systems. Since air movement through clothing is produced both by ambient air movement and by the subjects' movements, low air

MILITARY ERGONOMICS DIVISION

SIGNIFICANT RESEARCH FINDINGS/DEVELOPMENTS:

permeability may account for much of the additional physiological strain in uniforms made of the 3M material. In addition. unmeasured physical characteristics, such as stiffness or the ease with which the fabric systems move over underwear and skin, could affect air movement inside and through the uniforms, and thus their heat transfer properties.

Wearing the M17 or M25 (chemical-biological protective) masks as part of the soldier's protective (MOPP) equipment, impairs the performance of moderate and high activity tasks encountered in military operations. We tested the relationship between an individual's ability to judge the size of added inspiratory resistive loads, and how well and by what means, they maintain ventilation during exercise. Testing of the effects of respiratory load sensation on ventilatory control, and the performance of submaximal exercise was completed in May 1986. Several areas of analysis have included ventilatory responses to loaded breathing, and rated perceived exertion during constant effort exercise. Positive relationships were observed between hypercapnic sensitivity (S) and magnitude estimation (ME), suggesting an interaction between respiratory mechanoreceptors and the production of the hypercapnic response, and between each subject's peak $\dot{V}O_2$ and both S and ME. These relationships indicate that aerobic power may modify respiratory sensitivity to mechanical and hypercapnic stimulus. An inverse relationship between rated perceived exertion during steady-state submaximal exercise, and power output durng constant effort exercise was observed.

A chemical threat agent protective patient wrap (WRAP) has been developed to protect casualties from exposure to chemical agents during evacuation. Subjects have remained encapsulated in this WRAP for up to six hours in a comfortable (T_a = 27°C, rh = 50%) environment. However, the dry insulative value of the WRAP is 1.44 clo, and the permeability index is 0.25, which indicates that heat exchange would be limited by impaired evaporative heat loss. The tolerable encapsulation time for eight subjects was determined in four hot environments with a simulated solar heat load. The average time of encapsulation in these severely hot environments ranged from 38.4 (±5) min to 61.8 (±13.2) min, thereby showing that tolerable encapsulation was severely limited in hot environments which also had a marked solar heat load. A preliminary study (n = 2) indicated that encapsulation time in 54.7°C/17%rh could be extended by some 23 min by covering the WRAP with wetted towels, thereby decreasing body heat storage by significantly enhancing evaporative heat loss from the surface of the WRAP.

MILITARY ERGONOMICS DIVISION

SIGNIFICANT RESEARCH FINDINGS/DEVELOPMENTS:

Localized cutaneous vasodilation (flush) is seen following systemic atropine treatment. However, the regulation of this vasodilation was unknown. Forearm cutaneous blood flow as measured by venous occlusion plethysmography in a non-exercising limb increased in exercising subjects following an intramuscular injection of 2 mg atropine sulfate. The sensitivity of the measured forearm cutaneous blood flow to increasing esophageal temperature was increased by 85% compared to control experiments. Skin temperatures passively increased following the enhancement in cutaneous blood flow. The effect of systemic atropine on stimulation of increased cutaneous vasodilation is suggested to result by a combination of central and local responses, which may be mediated through the release of vasoactive substances.

A study compared upper body (arm crank) aerobic fitness for a group of women (n=8) and men (n=9) matched for lower-body (cycle) aerobic fitness ($\bar{X} \pm$ S.E. = 50 ± 2 ml kg^{-1}) and also examined the influence selected physiological factors had on upper-body exercise performance. The components of upper-body exercise studied included maximal power output (PO_{max}), peak oxygen uptake (peak $\dot{V}O_2$), elbow isokinetic strength and endurance, arm volume and endurance time at 80% arm crank peak $\dot{V}O_2$. During maximal effort upper-body exercise, there was no difference in peak $\dot{V}O_2$ ($ml \cdot kg^{-1}$) between the genders despite the men's significantly greater strength, arm volume and PO_{max}. Likewise, there was no difference in upper body endurance time at 80% peak $\dot{V}O_2$ between the genders. These data indicated that (a) women are not at a disadvantage in performing aerobic upper-body exercise; (b) skeletal muscle strength provides a relatively minor influence on both maximal effort and prolonged upper-body exercise; and c) individuals can perform prolonged upper-body exercise at relative intensities greater than that needed to elicit an aerobic training effect.

A study was conducted to describe the frequency constant of the electromyogram (EMG) recorded during shivering and determine if the EMG power spectrum changed as a function of the shivering duration. Six semi-nude males were exposed to cold air (5°C, 20% rh) for 80 min while quietly sitting. Rectal (T_{re}) and mean skin (T_{sk}) temperatures were recorded. Shivering of the masseter muscle was determined using bipolar surface electrodes. The EMG was amplified, recorded, and subsequently digitized at 2048 Hz. The power spectrum was calculated from eight serial 0.25g EMG samples by Fourier analysis from a frequency of 4 through 480 Hz. The eight power spectra were averaged and centroid frequency (f_c) calculated. During the first 10 min of exposure, T_{sk} rapidly dropped from 32.6±1.6 to 26.2±1.3°C, then slowly declined reaching 22.5±0.7°C after 80 min. T_{re} rose from 37.1±0.1 to

MILITARY ERGONOMICS DIVISION

SIGNIFICANT RESEARCH FINDINGS/DEVELOPMENTS:

37.4±0.1°C declining after 40 min to 37.2±0.1°C. Shivering was observed within 5 min after entering the cold chamber. EMG activity after 10 min exhibited an f_c of 177.2±6.2 Hz. When power was integrated over 60 Hz bandwidths, the predominant frequency band of the EMG power spectrum was 60-120 Hz. Although shivering intensity increased with time, the EMG power spectrum exhibited no significant changes. These results suggest that the EMG power spectrum during shivering did not exhibit changes characteristic of muscle fatigue or muscle cooling during the 80-min cold air exposure.

A sweating hot plate with its environmental box was purchased; this should allow USARIEM to compare values of NATO clothing properties in conjunction with our conventional hot plate.

Biophysical assessments were finished on closed-cell foam innerboots used with popular commercial nylon-shell high altitude mountaineering boots. Results showed that volume expansion by some 23% occurred at simulated altitude (18,000 ft.). This compression has implications related to the increase in frostbite of feet in climbers at high terrestrial environments.

Eleven formal modelling consultations were prepared off the USARIEM heat stress prediction model which is indicative of the great need for determination of optimum simulation for planning operations prior to field maneuvers or user trials involving extensive materials and human experimentation.

A method was devised to determine the heat transfer properties of the head by use of a copper model which is unique and allows independent evaluation of head gear. Seven helmets were evaluated including prototype military motorcycle for use in high ballistic impact and an Israeli Defence Forces (IDF) tank helmet. At most 10 to 17% evaporative cooling is possible with military motorcycle helmets and some 34% with IDF prototypes.

Biophysical evaluations were finished on a variety of cold weather handwear, footwear and clothing materials. A protypical cold weather clothing system proved to have a high thermal insulation value compared to U.S. Arctic wear, but it is filled with foam material and, therefore, dubious in durability for extended wear.

This Division inputted into the development of an improved aircrew chemical defense garment and completed copper manikin evaluations of the prototype suits for the Air Force.

USARIEM
CY86

MILITARY ERGONOMICS DIVISION

SIGNIFICANT RESEARCH FINDINGS/DEVELOPMENTS:

A new procedure for footwear insulation evaluation was developed which incorporates application of 70 kg of pressure to simulate compression by a person's body mass and evaluation of extended cold-water soaking.

A new technique was initiated for the evaluation of heat-mass transfer characteristics of the articulated-moveable manikin which employs flush mounted naphtalene cassettes. Sublimation into the atmosphere is a direct property of air motion so coefficients can be accurately obtained.

A development of a new thermoregulatory model began which incorporates much of the theory of previous models but will have options of cold-water regulation derived from the extensive USARIEM database.

PUBLICATIONS:

Arens, E., R.R. Gonzalez and L.G. Berglund. Thermal comfort under an extended range of environmental conditions. ASHRAE Trans. V92, PA 1, 1986.

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Sawka, M.N., A.J. Young, C.B. Wenger and K.B. Pandolf. Human Exercise and Heat Exchange in Thermal Environments. In: Crt. and Emerg. Issues in Biomed. Eng. C.J. Robinson and G.V. Kondraske, Eds., Piscataway: IEE/EMBS, 48-51, 1986.

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USARIEM
CY86

MILITARY ERGONOMICS DIVISION

ABSTRACTS:

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Pimental, N.A., A.M. Poston and M.N. Sawka. Thermal responses of soldiers rearming aircraft in warm environments. Aviat. Space Environ. Med. 57:505, 1986.

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USARIEM
CY86

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ABSTRACTS:

Young, A.J., J.T. Reeves, A. Cymerman, H.S. Huang, R.E. McCullough, R.G. McCullough, L.b. Moore, P.B. Rock, P.M. Young, D. Bloedow and J.V. Weil. No propranolol effect on O_2 uptake during exercise at high altitude. Fed. Proc. 45:883, 1986.

PRESENTATIONS:

Brebbia, D.R. N.M. Bark and R.R. Gonzalez. Heat stress and thermoregulation in schizophrenia. Am. Psychiatric Assn. Symposium, Washington, DC, May 1986.

Gonzalez, R.R. and M.A. Kolka. Heat exchange responses to anticholinergics. Heatstroke in psychiatric patients. Am. Psychiatric Assn. Symposium, Washington, DC, May 1986.

Gonzalez, R.R. Presentation of series of lectures to Arctic Medical Council, Oulu, Finland, September 1986.

Gonzalez, R.R. Series of lectures on environmental biophysics. Federation of American Societies for Experimental Biology, minority institutions lecture roster, Flagstaff, AZ, October 1986.

Levell, C.A. Biophysical devices for measuring heat transfer through clothing materials. 2nd International Environmental Ergonomics Conference. Whistler, British Columbia, July 1986.

Pandolf, K.B. Environmental factors during exercise/fitness. Third Annual Physical Medicine Short Course, Walter Reed Army Medical Center, Washington, D.C., March 1986.

Pandolf, K.B., M.M. Toner, W.D. McArdle, J.R. Magel and M.N. Sawka. Influence of body mass, morphology and gender on thermal responses during immersion in cold water. Paper presented at the 9th International Symposium on Underwater and Hyperbaric Physiology, Kobe, Japan, September 1986.

Santee, W.R. and T.L. Endrusick. Heat loss from boots under simulated field conditions. 2nd International Environmental Ergonomics Conference, Whistler, British Columbia, July 1986.

MILITARY ERGONOMICS DIVISION

PRESENTATIONS:

Sawka, M.N. The tri-service performance physiology program for the development of chemical warfare pre-treatment drugs. Joint Working Group for Chemical Warfare Pre-Treatment Drug Development: In Process Review Symposium. Frederick, MD, January 1986.

Sawka, M.N. Effects of sleep loss on exercise performance and thermoregulation. Tutorial Symposium on Circadian Rhythm. Aerospace Medical Association, Nashville, TN, April 1986.

Sawka, M.N. Temperature regulation during exercise. Symposium on the Pathophysiology of Exercise. 15th Annual Meeting of New England Physiologists, Grafton, MA, September 1986.

Sawka, M.N. Human exercise and heat exchange in thermal environments. Symposium on Critical and Emerging Issues in Biomedical Engineering, IEE/Engineering in Medicine and Biology Society Meeting, Ft. Worth, TX, November 1986.

Young, A.J., S.R. Muza, M.N. Sawka and K.B. Pandolf. Cold acclimation can be induced in humans by repeated cold water immersion. Paper presented at the 9th International Symposium on Underwater and Hyperbaric Physiology, Kobe, Japan, September 1986.

KEY BRIEFINGS:

Richard R. Gonzalez, Ph.D. Biophysical assessment of CW protective clothing; P^2NBC^2 Symposium, USARIEM, Natick, MA, January 1986.

Richard R. Gonzalez, Ph.D. Chemical protective clothing and equipment; NATO RSG-7 Biomedical Research Aspects of Military Clothing, Copenhagen, Denmark, September 1986.

Richard R. Gonzalez, Ph.D. Work in the North - physiological aspects; Arctic Medical Council, Oulu, Finland, September 1986.

Kent B. Pandolf, Ph.D. Human thermoregulation at environmental extremes. Department of Physiology, State University of New York at Buffalo, Buffalo, NY, December 1986.

Michael N. Sawka, Ph.D. Overview of thermal physiological research; P^2NBC^2 Symposium, USARIEM, Natick, MA, January 1986.

MILITARY ERGONOMICS DIVISION

KEY BRIEFINGS:

Michael N. Sawka, Ph.D. Chemical warfare protective clothing: Identification of problems and their solution; P^2NBC^2 Symposium, USARIEM, Natick, MA, January 1986.

Michael N. Sawka, Ph.D. Use of erythrocythemia for artificial acclimation to exercise-heat stress. Naval Blood Research Laboratory/Boston University School of Medicine, Boston, MA, March 1986.

Michael N. Sawka, Ph.D. Influence of hydration level and body fluids on exercise performance in the heat. Southern Illinois University at Carbondale, Carbondale, IL, April 1986.

Michael N. Sawka, Ph.D. Influence of hydration level and body fluids on exercise performance in the heat. State University of New York at Buffalo, Buffalo, Buffalo, NY, June 1986.

Michael N. Sawka, Ph.D. Physiology of the female athlete. New England Sports Medicine Program, Barnstable, MA, July 1986.

Michael N. Sawka, Ph.D. Cardiovascular control mechanisms during exercise. MGH Institute of Health Professions, Massachusetts General Hospital, Boston, MA, November 1986.

Leander A. Stroschein and M.N. Sawka, Ph.D. Modeling approach to protective clothing heat strain; P^2NBC^2 Symposium, USARIEM, Natick, MA, January 1986.

Leander A. Stroschein. Heat stress prediction model; NRDEC/USAIS Joint Program Review, June 1986.

Andrew J. Young, Ph.D. Heat stress associated with wearing of chemical protective clothing: Physiological and Psychological performance in a nuclear, biological and chemical environment; P^2NBC^2 Symposium, USARIEM, Natick, MA, January 1986.

Andrew J. Young, Ph.D. Skeletal muscle metabolism during exercise in extreme environments. Seminar at the Letterman Army Institute of Research, Presidio of San Francisco, CA, June 1986.

Andrew J. Young, Ph.D. Effects of acclimation to heat and high altitude on man's capacity for maximal and submaximal exercise. Seminar presented to Pulmonary Unit, Massachusetts General Hospital, Boston, MA, December 1986.

USARIEM
CY86

MILITARY ERGONOMICS DIVISION

SIGNIFICANT TDY:

Richard R. Gonzalez, Ph.D. To participate in RSG-7 Working Group of NATO Handbook, Copenhagen, Denmark, September 1986.

Andrew J. Young, Ph.D. To participate as U.S. Army project officer to Project Group 114 of the Annual Meeting of Working Party 61 of the Air Standardization Coordinating Committee, Auckland, New Zealand, October 1986.

SIGNIFICANT VISITORS:

Edward Arens, Professor, University of California, Berkeley, California.

Dr. Werner Gehrmann, Institute fur Wehrmedizin und Hygiene, Federal Republic of Germany.

Dr. Juergen Mecheels, Director, Hohenstein Institute, Federal Republic of Germany.

Dr. Karl Umbach, Hohenstein Institute, Federal Republic of Germany.

PROFESSIONAL APPOINTMENTS/ACTIVITIES:

Richard R. Gonzalez, Ph.D. Adjunct Professor, Environmental Science and Physiology, Harvard School of Public Health, Harvard Medical School, Boston, MA.

Kent B. Pandolf, Ph.D. Adjunct Professor, Department of Health Sciences, Sargent College of Allied Health Professions, Boston University, Boston, MA.

Kent B. Pandolf, Ph.D. Adjunct Professor of Environmental Medicine, Springfield, College, Springfield, MA.

Kent B. Pandolf, Ph.D. Editor, Exercise and Sport Sciences Reviews.

Kent B. Pandolf, Ph.D. Editorial Board Member, Medicine and Science in Sports and Exercise.

MILITARY ERGONOMICS DIVISION

PROFESSIONAL APPOINTMENTS/ACTIVITIES:

Kent B. Pandolf, Ph.D. Editorial Board Member, Ergonomics.

Kent B. Pandolf, Ph.D. Co-chairman, Session on Physiology of Diving and Hyperbaria, International Symposium on Physiology of Stressful Environments, Kitakyushu, Japan.

Michael N. Sawka, Ph.D., Member, Special Study Section on Physical Activity and Assessment, National Institutes of Health.

Michael N. Sawka, Ph.D., Adjunct Associate Professor, Department of Physical Therapy, Sargent College of Allied Health Professions, Boston University, Boston, MA.

C. Bruce Wenger, M.D., Ph.D. Visiting Research Associate in Physiology, School of Public Health, Harvard University.

C. Bruce Wenger, M.D., Ph.D. Working Group 11, Subcommittee C95.1-IV, American National Standards Institute.

C. Bruce Wenger, M.D., Ph.D. Visiting Associate Fellow, John B. Pierce Foundation Laboratory, New Haven, CT.

Andrew J. Young, Ph.D. Member of the Public Relations Committee of the American College of Sports Medicine.

MILITARY
NUTRITION RESEARCH DIVISION

SIGNIFICANT RESEARCH FINDINGS/DEVELOPMENTS:

A 2000 kcal lightweight ration (RLW-30) was tested as the sole source of food for 30 continuous days during a Special Forces field training exercise (FTX) in September and October, 1986 at Camp Ethan Allen, VT. Eighteen Special Forces soldiers were assigned to the RLW-30 group and another 18 were assigned to a calorie adequate control ration (MRE VI). Both groups of soldiers performed similar missions at the same location but were physically separated from each other. A battery of physical and psychological tests was conducted before, during and after the 30 day FTX. Food and water intakes were recorded daily and nutritional and hydration status were evaluated. Medical examinations were conducted before, during and after the FTX. Soldiers consuming the RLW-30 ration lost an average 11.4 lbs/man (6.3% of original body weight) compared to 4.0 lbs/man (2.2% of original body weight) for the MRE group. The weight loss for the MRE group was provided by body fat loss. The weight loss for the RLW-30 group came from a combination of body fat and lean body mass. Aerobic capacity decreased 10.2% for the MRE group and 14.8% for the RLW-30 group. Isokinetic muscle strength and endurance did not decrease in the MRE group but decreased 3.1 and 7.9% respectively in the RLW-30 group. There were no differences between groups in handgrip strength or PT test performance. Vigilance, mood, morale and cognitive ability were maintained to a similar degree in both groups. Medical examinations did not reveal serious medical problems and there was no evidence of direct ill effects from the ration. The results of this study indicate that the RLW-30 ration, if used as a sole source of food for 30 days, can be expected to cause some uncomfortable physical symptoms and a small to moderate decrement in physical performance capacity that should be considered in mission planning; however, the RLW-30 is capable of supporting the health and performance of Special Operation Soldiers for light activity missions of up to 30 days duration.

The most comprehensive test and evaluation ever of a Combat Field Feeding System (CFFS) was conducted with approximately 1650 soldiers from the 25th Infantry Division engaged in a seven-week field training exercise during Aug-Sept 1985 at the Pohakaloa Training Area, Hawaii. The primary nutritional problems identified for certain ration alternatives was inadequate caloric intake to meet the energy demands of moderate physical activity and low fluid consumption resulting in less than optimal hydration status, especially during the first few days of the exercise. Calcium intakes were low when milk was not available. The new T-ration system resulted in fat and cholesterol intakes which met current dietary guidelines. The results of this study were

MILITARY
NUTRITION RESEARCH DIVISION

SIGNIFICANT RESEARCH FINDINGS/DEVELOPMENTS:

briefed to the Chief of Staff Army in March 1986, and the nutritional recommendations are now being incorporated into revised menus.

The results of a six-day study (Askew et al, Fed Proc. Vol 45:p 972, 1986) of soldiers acutely translocated and bivouacked at 4100 M altitude indicated that carbohydrate supplementation of the Meal-Ready-to-Eat is beneficial during strenuous exercise at high altitude. Running endurance (distance covered per 2 hr) increased 10-15% with carbohydrate supplementation. Our laboratory also completed two additional high altitude studies this past year which included nutritional aspects. Total food nutrient and water consumption was carefully measured during a 35-day simulated gradual ascent to Mt. Everest (8,500 M) in the USARIEM hypobaric chamber. In the second study, the effects of caffeine ingestion on exercise performance and carnitine excretion was compared at sea level and during a 14-day exposure to high altitude (4,300 M) at our Pikes Peak, Colorado Facility.

During February 1986, we conducted a 10-day field evaluation of a prototype packaged Ration, Cold Weather (RCW). The RCW (4500 Kcal) was compared with 4 MRE meals per day (4800 Kcal) with Special Forces troops conducting winter training in the White Mountains of New Hampshire. The preliminary results indicate that the RCW, although providing logistical advantage (lower weight, and volume), was not effective in overcoming problems of low calorie consumption, body weight loss and hypohydration. We currently are assisting with a human study to evaluate whether carbohydrate loading will increase resistance of hypothermia as measured by the thermoregulatory response to cold water immersion.

Our laboratory had the opportunity to quantify actual calorie and nutrient consumption during an 8-day sustained artillery training exercise at Fort Sill, OK, during June 1986. The soldiers were fed 3 hot A-ration meals per day and consumed sufficient calories (3650 Kcal) to maintain energy balance and not incur a body weight loss. This study documented that troops served sufficient quantities of foods they like and provided the time to eat it will consume sufficient calories to maintain body weight even during strenuous field training exercise.

USARIEM
CY86

MILITARY
NUTRITION RESEARCH DIVISION

SIGNIFICANT RESEARCH FINDINGS/DEVELOPMENTS:

At the request of the Deputy Chief of Staff for Logistics, we conducted the first in a series of dietary assessment studies to evaluate the effectiveness of nutritional initiatives for garrison dining facilities. Food and nutrient consumptions and nutritional awareness were measured during an eight-day study at the NCO Academy at Fort Riley, Kansas in August 1986. The preliminary results indicate that progress has been made in reducing garrison dining hall fat intakes but further progress is necessary to meet the current nutrition initiatives.

PUBLICATIONS:

Askew, E.W. Changing nutritional requirements for the armed forces of the future. Calorie dense or carbohydrate rich? *Activities Report of the R and D Associates*, Published by the Research and Development Associated for Military Food and Packaging Systems, Inc. 38(1):69-73, 1986.

Askew, E.W. Effect of protein, fat, and carbohydrate deficiencies on performance. In: Predicting Decrements in Military Performance Due to Inadequate Nutrition. National Academy Press. Washington, D.C., 1986.

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Askew, E.W. Nutrition and performance in cold environments. Activities Report of the R and D Associates. Published by the Research and Development Associates for Military Food and Packaging Systems, Inc. 38(2):60-68, 1986.

Rose, M.S. and D.E. Carlson. Effects of A-ration meals on body weight during sustained field operations. USARIEM Technical Report No. T/2, 1986.

Schnakenberg, D.D., D. Carlson, M. Sawyers, J.A. Vogel, R. Johnson, P.C. Szlyk, R. Francesconi and R.W. Hubbard. Nutritional evaluation of a new combat feeding system for the Army. Proceedings of the Army Science Conference: Vol IV, p 69-80, 1986.

MILITARY
NUTRITION RESEARCH DIVISION

PUBLICATIONS:

Schnakenberg, D.D. Military nutrition research: A brief history and overview of future directions. Proceedings of a Workshop on Predicting Decrements in Military Performance Due to Inadequate Nutrition, National Academy Press. Washington, D.C., p 7-14, 1986.

_____ Combat Field Feeding System-Force Development Test and Experimentation (CFFS-FDTE) Test Report (CDEC-TR-85-006A) Vols, 1, 11 and 111. US Army Research Institute of Environmental Medicine and US Army Combat Developments Experimentation Center, January 1986. (Nutritional and Biomedical Chapters were authored by Schnakenberg, D.D., D. Carlson, M. Sawyers, J.A. Vogel, R. Johnson, P.C. Szlyk, R. Francesconi, and R. Hubbard)

ABSTRACTS:

Carlson, D.E., D.D. Schnakenberg, M. Sawyers, T. Dugan, K. Samonds. Effectiveness of combat field feeding system in meeting nutritional requirements of soldiers. New Visions New Ventures. American Dietetic Association Abstracts, pp. 80, 1986.

Rose, M.S., and A.N. Milner. Prediction of percent body fat in overweight males. Fed Proc 45:477;1986.

Askew, E.W., J.R. Claybaugh, G.M. Hashiro, W.S. Stokes, and S.A. Cucinell. Carbohydrate supplementation during exercise at high altitude. Fed Proc 45:972;1986.

PRESENTATIONS:

Askew, E.W. New military field rations-medical implications. 804 General Hospital Symposium. Newton, MA, April 1986.

Askew, E.W. Nutrition at environmental extremes. USARIEM Environmental Medicine Course. Natick, MA, May 1986.

Askew, E.W. Nutrition in cold environments. Nutrition and Human Performance Session. R and D Associates Meeting. Orlando, FL, April 1986.

Rose, M.S. Operation Everest II: Nutrition and body composition. American Physiological Society Meeting. New Orleans, LA, October 1986.

USARIEM
CY86

MILITARY
NUTRITION RESEARCH DIVISION

PRESENTATIONS:

Schnakenberg, D.D. Nutritional evaluation of a new combat field feeding system for the Army. U.S. Army Preventive Medicine Symposium. Washington, D.C., May 1986.

KEY BRIEFINGS:

Eldon W. Askew, LTC, MS, Ph.D. Nutritional Methods of Enhancing Soldier Performance; DCSPER's Soldier Performance Analysis and Review (SPRAR) Meeting, Fort Belvoir, VA, 1986.

David D. Schnakenberg, LTC, MS, Ph.D. Nutritional Findings from Combat Field Feeding System - Force Development Test and Evaluation (CFFS-FDTE); USANRDEC Personnel, Natick, MA, 19 February 1986.

David D. Schnakenberg, LTC, MS, Ph.D. Nutritional Findings from CFFS-FDTE; Deputy Surgeon General of the Army, Washington, D.C., 26 February 1986.

David D. Schnakenberg, LTC, MS, Ph.D. Nutritional Findings From CFFS-FDTE; GEN Maxwell Thurman, Vice Chief of Staff and GEN Wickham, Jr., Chief of Staff Army, Washington, D.C., 3 March 1986.

David D. Schnakenberg, LTC, MS, Ph.D. Nutritional Findings from CFFS-FDTE; Food and Nutrition Board, National Academy of Sciences, National Research Council, Washington, D.C., 18 March 1986.

David D. Schnakenberg, LTC, MS, Ph.D. Nutritional Findings from CFFS-FDTE; Mr. Walt Hollis, Deputy Under Secretary of the Army for Operational Research, Washington, D.C., 21 March 1986.

David D. Schnakenberg, COL, MS, Ph.D. Annual Review of Research Study Group-8: Nutritional aspects of military feeding. NATO Panel 8 Meeting, Brussels, Belgium, 22-24 April 1986.

David D. Schnakenberg, COL, MS, Ph.D. Nutritional methodologies for combat ration testing. TNO-CIVO Institute, Zeist, Netherlands, 28-29 April 1986.

David D. Schnakenberg, COL, MS, Ph.D. Nutritional methodologies for combat ration testing. Army Catering Corps Group Headquarters, Aldershot, UK, 30 April 1986.

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KEY BRIEFINGS:

David D. Schnakenberg, COL, MS, Ph.D. Current research interests at USARIEM. Army Personnel Research Establishment, Aldershot, UK and Institute of Naval Medicine, Gosport, UK, 1 May 1986.

David D. Schnakenberg, COL, MS, Ph.D. Recent Developments on the Meal, Ready-to-Eat (MRE) and Combat Field Feeding System; LTG Quinton Becker, Surgeon General of the Army, Washington, D.C., 2 June 1986.

SIGNIFICANT TDY:

Eileen G. Szeto, CPT, MPH. To attend Army Nutrition Planning Committee Meetings, Ft. Lee, VA, 4 March - 6 March 1987.

Madeleine S. Rose, MAJ, Ph.D. et al. Joint Army War College/USARIEM field artillery sustained operations study, Fort Sill, OK, June 1986.

Dawn E. Carlson, MAJ, MS et al. Garrison dining facility study, Fort Riley, KS, July 1986.

Madeleine S. Rose, MAJ, Ph.D. et al. Effects of altitude and caffeine on performance, Pikes Peak, CO, August 1986.

Eldon W. Askew, LTC, Ph.D. RLW-30 field study, Special Forces, Camp Ethan Allen, 26 Sep - 26 Oct 86.

Eileen G. Szeto, CPT, MPH et al. Garrison dining facility study, Fort Lewis, WA, November 1986.

SIGNIF CANT VISITORS:

Colonel Martha Cronin, Chief Dietitian Section, United States Army, Washington, DC.

Colonel Mildred Chambers, Chief Dietitian, United States Air Force, Washington, DC.

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SIGNIFICANT EVENTS:

USAMRDC Manpower survey report (dated 19 May 1986) validated 18 new manpower authorizations (5 military, 13 civilian) for the Military Nutrition Division.

PROFESSIONAL APPOINTMENTS/ACTIVITIES:

Eileen G. Szeto, CPT, MPH. Member, Army Nutrition Planning Committee.

Eldon W. Askew, LTC, Ph.D. Chaired Diet and Exercise Section of Federation American Society of Exptl. Biol. Meeting, St. Louis, MO.

Eldon W. Askew, LTC, Ph.D. Reviewer for American College of Sports Medicine Diet and Exercise Abstract submissions for 1986 ACSM Annual Meeting.

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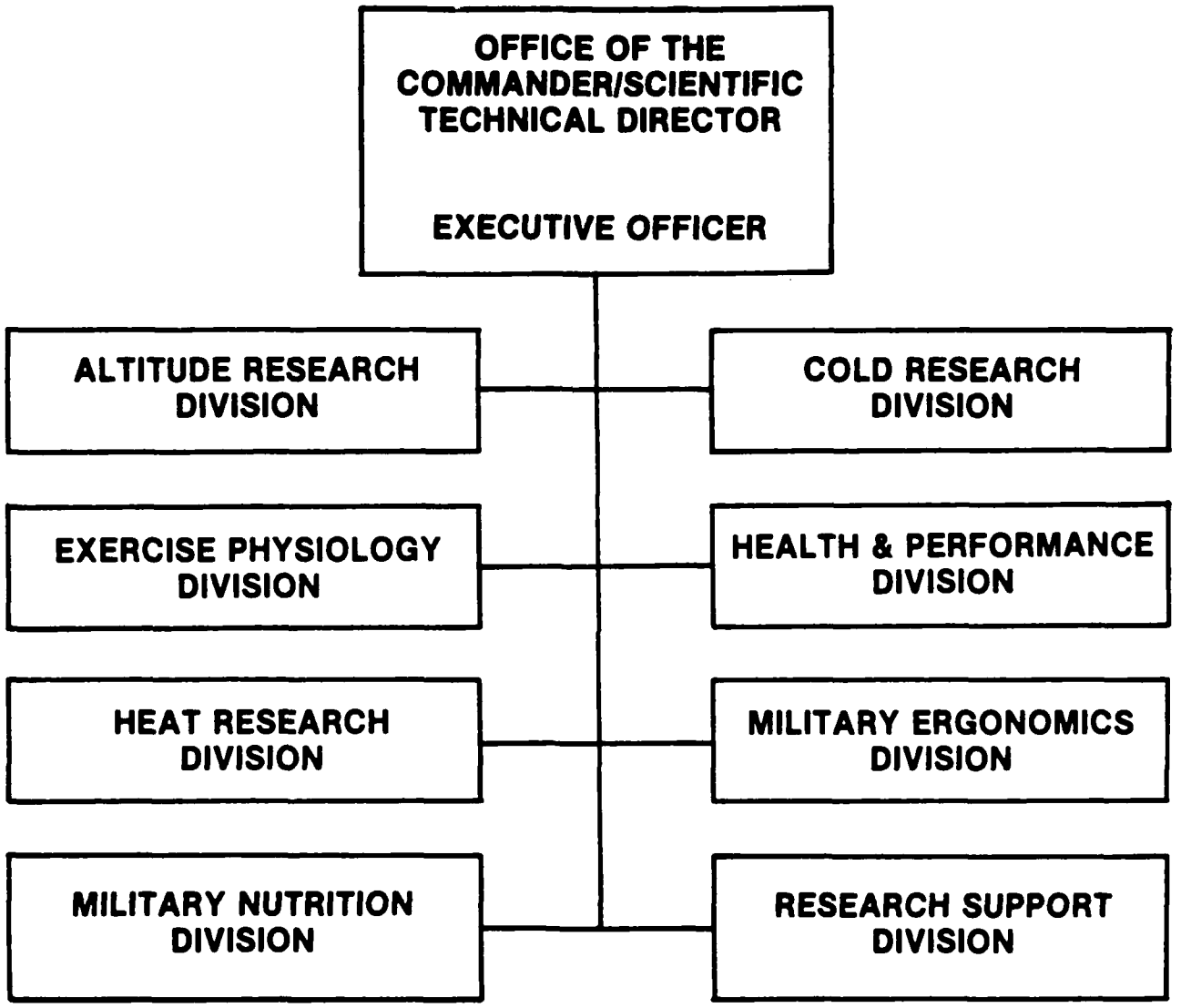

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