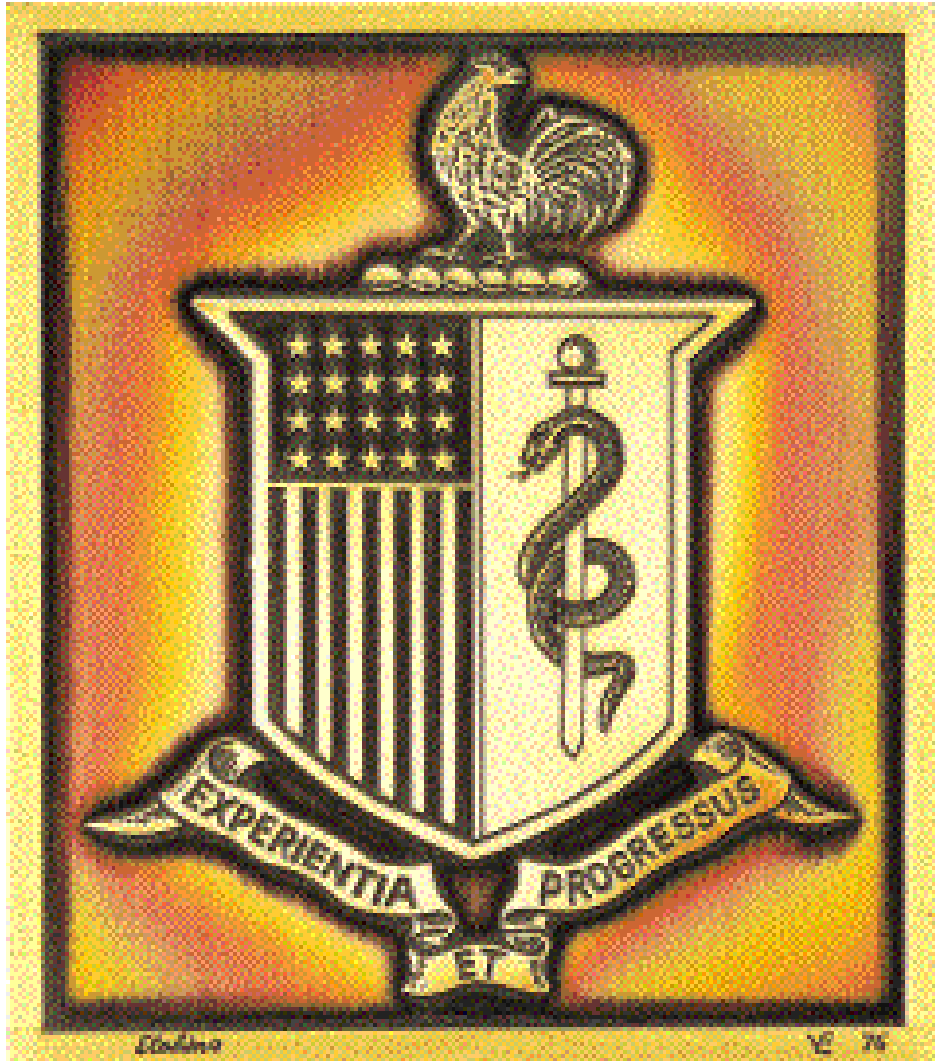


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**MEDICAL ASPECTS OF HARSH ENVIRONMENTS**  
**Volume 2**

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The Coat of Arms  
1818  
Medical Department of the Army

A 1976 etching by Vassil Ekimov of an original color print that appeared in *The Military Surgeon*, Vol XLI, No 2, 1917

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The first line of medical defense in wartime is the combat medic. Although in ancient times medics carried the caduceus into battle to signify the neutral, humanitarian nature of their tasks, they have never been immune to the perils of war. They have made the highest sacrifices to save the lives of others, and their dedication to the wounded soldier is the foundation of military medical care.

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The environments that face combatants on modern battlefields.

Art: Courtesy of US Army Research Institute of Environmental Medicine, Natick, Massachusetts

# MEDICAL ASPECTS OF HARSH ENVIRONMENTS VOLUME 2

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# Foreword

Earth's environments have always influenced the planning and conduct of military operations. Past campaigns have been impacted by heat, cold, and altitude, as well as the changes in barometric pressure that divers face in special operations. During the 20th century alone, US armed forces have been involved in terrestrial military operations in hot climates in the North African campaign and Pacific theater operations during World War II, the Vietnam and Persian Gulf wars, and military and humanitarian operations in Panama, Haiti, Grenada, Rwanda, and Somalia. Our major military operations involving cold climates during the past century include World War I and World War II, the Korean War, and most recently in Bosnia and Kosovo. *Medical Aspects of Harsh Environments, Volume 1*, treats the major problems caused by fighting in heat and cold.

The topics of *Medical Aspects of Harsh Environments, Volume 2*, are the effects of altitude, especially as experienced in mountain terrain and by aviators, and the complex interactions between humans and the special environments created by the machines used in warfare. Our warfighters were exposed to mountain terrain during World War II, the Korean War, in military and humanitarian efforts in South America, and most recently in the Balkans. Military action has also occurred in some of the environments considered "special" (eg, on and below the water's surface) in every war that this country has fought, whereas other special environments (eg, air—flights not only within Earth's atmosphere but also beyond it, in space) have become settings for the havoc of war only as a result of 20th-century technology. The second volume also contains a discussion of the personal environment within the protective uniforms worn by service members against the fearsome hazards of chemical and biological warfare. This microenvironment—created by the very encapsulation that protects the wearer—is in some ways different from but in others similar to all closely confined, manmade environments (eg, the stresses that divers face in coping with the changes in barometric pressure). Whatever the environment, this point needs to be kept in mind: indifference to environmental conditions can contribute as much to defeat as the tactics of the enemy.

*Medical Aspects of Harsh Environments, Volume 3*, emphasizes the need for a preventive approach to decrease attrition due to harsh environments, such as predicting the likelihood of its occurrence and stimulating awareness of how specific factors (eg, gender, nutritional status) are sometimes important determinants of outcome. The third volume concludes with reproductions of two of the classics of environmental medicine: the lectures given by the late Colonel Tom Whyne on heat and cold injury, respectively, at the Army Medical School in 1951; for decades these have been unavailable except as mimeographed handouts to students attending specialized courses.

Military and civilian experts from the United States and other countries have participated as authors of chapters in this three-volume textbook, *Medical Aspects of Harsh Environments*. The textbook provides historical information, proper prevention and clinical treatment of the various environmental illnesses and injuries, and the performance consequences our warfighters face when exposed to environmental extremes of heat, cold, altitude, pressure, and acceleration. The contents are unique in that they present information on the physiology, physical derangements, psychology, and the consequent effects on military operations together in all these harsh environments. This information should be a valuable reference not only for the physicians and other healthcare providers who prepare our warfighters to fight in these environments but also for those who care for the casualties. Military medical personnel must never forget that harsh environments are great, silent, debilitating agents for military operations.

Lieutenant General James B. Peake  
The Surgeon General  
U.S. Army

Washington, DC  
December 2001



# Preface

Over the centuries, battles have often been won by innovation: cavalry prevailed over infantry, elephants frightened horses, and mechanized vehicles dispersed chariots. Today, aircraft and rockets seem to make victory possible from a safer distance, but we are learning that even overwhelming airpower is not enough. Sooner or later, a war must be fought on the ground. Ground forces often face harsh environmental conditions—hot or cold, wet or dry—and often the terrain is rugged. The high mountain environment is cold and the air deficient in oxygen. Space travel and underwater operations also pose new and difficult problems.

Alexander the Great lost hundreds of men to mountain hazards. Napoleon's attack on Moscow was broken by winter. Mountain combat during both World War I and World War II caused many avoidable casualties from cold and altitude. In the 1962 Sino-Indian conflict, these mountain conditions cost the unacclimatized Indian troops more loss than fighting did. And the winter retreat of the US forces during the Korean War was nearly identical—except for altitude—to that which the British Army had experienced in Afghanistan a century earlier.

As this second of three volumes devoted to *Medical Aspects of Harsh Environments* goes to press, US and Allied forces are preparing to mark the first anniversary of their deployment to the windswept terrain of the Afghan plateau. The reality of American troop operations at 5,000 to 10,000 feet above sea level brings an unexpected timeliness to this volume. For the first time in history, the US military has had to wage sustained combat at high altitude. Troops have had to confront, and overcome, the hobbling effects of altitude sickness while encumbered with 80 lb of gear and negotiating their way across steep snow-covered slopes. One firefight in March 2002 between US Army Rangers and Afghan Taliban took place at 10,200 ft.

In conjunction with *Medical Aspects of Harsh Environments, Volume 1* (comprising Sections I and II, Hot and Cold Environments), this second volume provides a compendium of human biomedicine in the austere, and often overlapping, environments of heat, cold, and high altitude. In the first half of this textbook (Section III, Mountain Environments, Paul B. Rock, DO, PhD, Colonel, Medical Corps, US Army [Ret], section editor), the US Army Research Institute of Environmental Medicine (USARIEM) presents a comprehensive review of the history, physiology, pathophysiology, and management of altitude illness. The latter half of this volume (Section IV, Special Environments, Sarah A. Nunneley, MD, section editor) examines biomedical aspects of four special environments: aboard ship, the hyperbaric world of diving, supersonic aviation and spaceflight, and unique considerations of 21st century land warfare as it relates to Special Operations and protection from chemical and biological warfare.

USARIEM—particularly Kent B. Pandolf, PhD, and Robert E. Burr, MD, the specialty editors of the three volumes that compose *Medical Aspects of Harsh Environments*—is to be congratulated on the depth and thoroughness of their examination of nearly every aspect of deployed medicine. These volumes are a welcome and overdue contribution to the Textbooks of Military Medicine series.

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October 2002

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The current medical system to support the U.S. Army at war is a continuum from the forward line of troops through the continental United States; it serves as a primary source of trained replacements during the early stages of a major conflict. The system is designed to optimize the return to duty of the maximum number of trained combat soldiers at the lowest possible level. Far-forward stabilization helps to maintain the physiology of injured soldiers who are unlikely to return to duty and allows for their rapid evacuation from the battlefield without needless sacrifice of life or function.

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