

REVIEW ARTICLE

Challenges of Military Health Service Support in Mountain Warfare

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Introduction—History is full of examples of the influence of the mountain environment on warfare. The aim of this article is to identify the main environmental hazards and summarize countermeasures to mitigate the impact of this unique environment.

Methods—A selective PubMed and Internet search was conducted. Additionally, we searched bibliographies for useful supplemental literature and included the recommendations of the leading mountain medicine and wilderness medicine societies.

Results—A definition of mountain warfare mainly derived from environmental influences on body functions is introduced to help identify the main environmental hazards. Cold, rugged terrain, hypoxic exposure, and often a combination and mutual aggravation of these factors are the most important environmental factors of mountain environment. Underestimating this environmental influence has decreased combat strength and caused thousands of casualties during past conflicts. Some marked differences between military and civilian mountaineering further complicate mission planning and operational sustainability.

Conclusions—To overcome the restrictions of mountain environments, proper planning and preparation, including sustained mountain mobility training, in-depth mountain medicine training with a special emphasis on prolonged field care, knowledge of acclimatization strategies, adapted time calculations, mountain-specific equipment, air rescue strategies and makeshift evacuation strategies, and thorough personnel selection, are vital to guarantee the best possible medical support. The specifics of managing risks in mountain environments are also critical for civilian rescue missions and humanitarian aid.

Keywords: history, acute mountain sickness, medical support, acclimatization, preventive measure

Introduction

It is not possible to identify a specific event as the starting point of mountain warfare. However, the challenges of mountain warfare are not a modern phenomenon. As early as 500 BC, Sun Tzu expressed considerable respect for mountainous terrain in relation to war.¹ Many famous military leaders such as Alexander the Great, Hannibal, Napoleon, José de San

Martín, and Simón Bolívar experienced the hardships of mountainous terrain during their campaigns.^{2,3} Despite sophisticated technology and growing knowledge, mountainous environments still influenced military campaigns in the 20th century—for example, during World War I and the ongoing Indian-Sino-Pakistan border conflicts.^{2–5} Currently, the ongoing war against terrorism has brought mountain warfare once more into the focus of military planning. According to the North Atlantic Treaty Organization, mountainous terrain provides sanctuary for hostile forces, particularly terrorist organizations.⁶

The aim of the present review is to help leaders identify the main environmental hazards by introducing a definition of mountain warfare, understand how mountainous environments affect daily life and warfare, and

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Submitted for publication July 2017.

Accepted for publication January 2018.

Presented in part as a lecture at the 8th European Hypoxia Symposium, September 10, 2016, Poljčce, Slovenia.

summarize countermeasures to mitigate the impact of mountainous environments.

Methods

A selective PubMed and Internet search was conducted using the keywords (individually and in any combination) “military,” “history,” “mountain warfare,” and “high altitude.” Additionally, we searched bibliographies for useful supplemental literature and included the recommendations of the leading mountain medicine and wilderness medicine societies.

Definition of mountain warfare

We have developed a definition of mountain warfare, adopted from Pierce, that will assist military leaders in identifying environmentally challenging battle spaces in mountain areas or similar regions (Table 1).⁷ Mountain warfare should be regarded as fighting in terrain with elevation differentials of at least 300 m *and* additional characteristics, such as complex and rugged terrain, low temperatures, or challenging altitude. To emphasize the challenges of the particular terrain, the terminology used should include all characteristic fields (eg, high-altitude, cold-weather, rugged-terrain mountain warfare). Warfare with any elevation differentials but no additional characteristics should be referred to as normal warfare because no special equipment or training is needed, and every soldier should be able to deal with that topography. Naturally, gray zones and transition zones exist.

By comparison, severely compartmented terrain as well as snow and low temperatures do require special equipment and skills. We suggest considering these types as rugged-terrain warfare and cold-weather warfare to clearly emphasize the tactical, behavioral, and logistic challenges.

Arctic warfare and (high) altitude warfare are 2 extreme variations of environmentally challenging warfare. We define arctic warfare as fighting with constant windchill factor (not air) temperatures of -30°C . In such conditions, there is an increased risk of frostbite in exposed facial skin within 10 to 30 min for most people.⁸ An environment of this kind cannot be compared with a normal winter. Extra training and equipment are essential.

Above 2500 m, there is a risk of altitude sickness for nonacclimatized individuals.⁹ Above 5500 m, no permanent human habitation is possible.¹⁰ However, the effects of hypobaric hypoxia can already be observed in the form of a reduction of maximum aerobic capacity and endurance even at 1500 m.¹¹ We have established the categories “moderate-altitude,” “high-altitude,” and “extreme-altitude” warfare to give consideration to the major influence of altitude on warfare.

Health service support in mountain warfare and lessons from the past

Much information exists on mountain warfare in general, but publications which cover the health service support requirements are very limited.⁵ Until World War I specialized mountain warfare units were rare.¹² Therefore, no specialized mountain warfare health support units existed. During World War I, the German Empire and Austria-Hungary were still not prepared for mountain warfare from a medical point of view, despite the foundation of mountain warfare units. Also, the Wehrmacht mostly had to improvise when evacuating casualties during mountain warfare, despite intensive progress in technical mountain rescue and the purchase of special medical equipment suitable for mountain operations in the 1930s.⁵ Many additional casualties

Table 1. Different types of warfare

	Type of Warfare	Definition
1	Mountain warfare	Elevation differentials exceeding 300 m <i>in addition to items 2, 3, 4, 5, 6, or 7</i>
2	Rugged-terrain warfare	Severely compartmented or complex terrain , with
3		<ul style="list-style-type: none"> ● mean slope angles of 45° <i>and/or</i> ● difficult terrain (UIAA II^a or higher)
4	Arctic warfare	Persistent ambient windchill factor temperatures below -30°C
5	Moderate-altitude warfare	Heights between 1500 m and 2500 m above sea level (normobaric conditions)
6	High-altitude warfare	Heights that exceed 2500 m above sea level (hypobaric hypoxia)
7	Extreme-altitude warfare	Heights that exceed 5500 m above sea level (extreme hypobaric hypoxia)

UIAA, Union International des Associations d'Alpinisme (International Climbing and Mountaineering Federation)

^a UIAA II requires the movement of one limb at a time and a proper setting of the movements.⁵¹

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