Emergency Medicine in Extreme Land Sports: The Need for a Medical Physician in an Extreme Sports Rescue Team

Muhammad Zeitsev Azman

University of Zagreb Medical Faculty
Abstract

Over the period of 20 years, the prevalence of extreme sports and outdoor activities has risen. Although most of the professional extreme athletes are practicing in protected circles and have experiences and contacts with primary emergency care and ambulatory support, the majority of outdoor activities are done by 'weekend' athletes who rely on the current medical care available within the area. When these athletes get injured, it usually takes time for emergency rescue groups to come to their aid. The injuries involved can be traumatic or incapacitating from orthopedic injuries. Other injuries may include myocardial infarctions, an emergency situation that is very dependent on the time of response. The fastest rising extreme sport in woodland areas is mountain biking, thus there is an abundance of articles related to mountain biking injuries. This literary review is aimed on determining the common types of injuries encountered while mountain biking in remote woodland areas, the response time of the rescue team and the possible benefit of having a medical doctor for better health care. Although there is medical care available to these athletes, there can be some improvement in equipment, response time, in increasing the level of emergency care to possibly provide onsite treatment to many types of injuries before transportation to the nearest medical center.

Key words

Sports medicine; remote emergency medicine; orthopedic injuries, response time; rescue medical equipment; extreme sports; mountain biking.
Literary Review

Introduction

The art and science of medicine has grown so extensively to include almost every aspect of our lives; from primary care to the most specific and specialized diagnostic techniques and treatments. This is because every person has the right to every type of health care, be it in big cities or remote areas (1). However even dealing with simple injuries, remote or 'peripheral' areas are hardly covered by proper medical care and most diagnostic and treatment options are usually referred to a general hospital or county hospital that are not in proximity of these injured athletes (2).

There is a significant population of people who explore, exercise and train in these areas for themselves and professional competitions. Most of these sports done by these athletes are considered to be ‘extreme’ (see table 1) (3). Extreme sports in the wilderness setting are considered to be dangerous because of the difficulty in finding and rescuing athletes who injure themselves in the different sports that they do. From climbing to mountain-biking, the types of injuries are different and need to be tended to individually and the treatments must be improvised for the situation and with the equipment available (4).

Table 1 Extreme sports encountered in the wilderness setting.

<table>
<thead>
<tr>
<th>Adventure racing</th>
<th>All terrain boarding</th>
<th>ATV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Base jumping</td>
<td>Bicycle motocross</td>
<td>Bungee jumping</td>
</tr>
<tr>
<td>Canopying</td>
<td>Mountain climbing</td>
<td>Freestyle motocross</td>
</tr>
<tr>
<td>Hang gliding</td>
<td>Whitewater rafting</td>
<td>Mountain-biking</td>
</tr>
</tbody>
</table>

Adapted from: Hyde TE, Gengenbach MS. Conservative Management of Sports Injuries.

Although there are many extreme sports in the wilderness setting, the injuries reported are still categorized within the vast scope of ‘accidents’, so there are a lack of statistic and research done on the types of injuries and the times of retrieval from wilderness settings. This is partially due to rescue teams not releasing information and also because it is not a requirement from medical associations (5). However since mountain-biking is one of the fastest growing sports due to the creation of off-road bicycles in the 1970s and the financial availability of a simple thrill, there has been a steadily increasing rate of injuries (6) that can parallel the other extreme sports in wilderness settings listed above.

From the 1970s, sales of mountain bikes have increased steadily and in 1993, 90% of the bikes sold in the United States were mountain bikes (7). Since mountain-biking involves speed, skill and high risks, there are some papers available listing statistics on mountain-bike related injuries. A simple PubMed search with the strings of extreme, sports and injuries came up with 188 articles; most articles being case studies on injuries ranging from decompression sickness to orthopedic injuries. A more refined search for mountain, biking and injuries yields 32 published articles with statistical analysis. Thus this paper will focus on the retrieval and injuries related to mountain-biking, because it is the fastest growing wilderness extreme sport and injury rates and demographics have been published in several journals across the world.

This paper will also suggest the need for a specialized medical doctor to be in more remote areas to deal with emergency first aid, orthopedic care and cardiac support to provide more than just primary care so more accurate care can be given and the ‘golden hour’ can be extended for traumatic injuries until the patient arrives to the...
closest health care facility for tertiary support and rehabilitation. If there is a need for care up to the tertiary setting, like winter rescue teams, then there is also a need for specialized equipment and transport vehicles to find, treat and support the patient for the most common injuries found in these athletes.

**Search and Rescue in Remote Areas**

Professionals in competition will usually have their own transport vehicles in case of injury, but most of the ‘weekend warriors’, who ride, run, mountain climb or hike, do not have quick access to professional privileges to first aid or remote primary care (8). These groups of people then have to rely on rescue teams and regional ambulatory support to get them to a health care facility. The transport vehicles, when responding to an emergency, will then have to search for and find the patient, prepare the patient for transport through non-urban terrain and get the patient to the closest competent health care facility (9).

However, some places do not have the transport capabilities to get patients back to the closest facility on time. The Mountaineer Area Rescue Group (MARG) in the Appalachian Trail, for instance, reports up to 3.5 hours response times. The average reported time in their primary zone (see figure 1; in purple) is within 60 minutes, but that is without returning with the patient back to a tertiary center (10). Getting these patients transported within the 60 minutes is usually needed because of the injuries experienced by these athletes (11). Although the majority of these injuries are sprains and abrasions that can easily be treated by first aid techniques taught to the paramedics, broken bones, internal hematomas, shock, myocardial infarctions and other more serious injuries usually have to be treated in facilities found in general or county hospitals (12).

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**Figure 1** (from previous page) (a) Response times for MARG from the initial call and (b) adjusted response time with help from other rescue groups associated with the Appalachian Search and Rescue Conference (ASRC). The ASRC consists of: Allegheny Mountain Rescue Group, Blue Ridge Mountain Rescue Group, DELMARVA Search and Rescue, Maryland Search and Rescue, Mountaineer Area Rescue Group, Piedmont Search and Rescue, Potomac Valley Search and Rescue, Shenandoah Mountain Rescue Group, South West Virginia Mountain Rescue Group and Tidewater Search and Rescue. Estimated Response Times: purple - 0 to 1.5 hours; green - 1.0 to 2.5 hours; pink - 2.0 to 3.5 hours; and blue - 3.0 to 4.5 hours.
Another example of a rescue team would be the Gorska Služba Spašavanja (GSS) in Croatia. The GSS is a mountaineering organization which provides support for injured or stranded individuals in the mountain ranges of Croatia. Since there is a reliable road network around the mountain ranges of Medvenica in Zagreb, Croatia; the average time to reach the injured person is around 30 minutes and within 5 minutes during winter and their regular duties. The GSS has around 30 search missions a year with a total of about 150 interventions. Most of these people are without serious injury due to extreme sports and are usually hypothermic, exhausted and disoriented. The more serious injuries encountered are extremity injuries, head and neck injuries or myocardial infarctions. However when there is an opportunity for rescue, the GSS can only offer advanced first aid, because they are not paramedics and can only support the patient until medical help arrives (13).

Although many countries have a mountaineering rescue team and most of the paramedics or volunteers can provide adequate emergency first aid, the training of paramedics for improvising health care in remote areas to treat and support patients until they reach a medical facility is not standardized. Thus some medical associations have been started; such as in the case with the Wilderness Emergency Medical Services Institute (WEMSI) in the United States to try to standardize education for pre-hospital situations and while waiting for prolonged transport (4). In peripheral situations, there is hardly any support beyond primary care and if a medical doctor is present and specially trained to get to the injured patients, then there can be a new specialty in medicine specifically tailored to injuries encountered by the athletes doing extreme sports in remote areas.

Although WEMSI is still relatively new, there have been more established rescue teams with almost a century of experiences in dealing with a lot of annual injuries. In 2007/2008, there has been 101,111 emergency room or hospital visits in the United States for ski-related injuries (14). Rescue groups for skiers and other extreme winter sports therefore have more experience and an already established support because of the demands of injuries; i.e. the Ski Injury Clinic in Perisher Valley in New South Wales, Australia (15).

Each ski rescue team still works on a volunteer basis, but they are required to go through rigorous training to provide advanced primary care to winter athletes involved in anything from cross-country skiing accidents to snow-mobile accidents (16). However, even though the winter sports rescue teams have guidelines and are more experienced, they still rely on first aid, primary care and transport of the patient to a tertiary care center.

**Injuries in Extreme Sports**

The most common injuries encountered during extreme activities in forest and woodland areas are usually sprains and abrasions. However there are a significant number of other injuries including the head and face, the cervical spine, the upper limbs, the abdominal viscera, the perineum and the lower limbs (17). These more serious injuries that prevent a rider from continuing, which encompass 0.40-0.50% of mountain-biking related injuries, require tertiary diagnostic techniques and treatment (see figure 2) (18). The cases, when falling off the bicycle and into the handle bars, are more severe due to trauma to the head and neck (19). There is even a possibility for a sub-clinical myocardial infarction in extreme athletic situations (20).
that might lead to a full infarct in some weekend athletes. In order to get better care to the patient on time, a medical doctor can be allocated with these transport groups to provide more than advanced first aid and possibly provide onsite treatment for more difficult cases.

<table>
<thead>
<tr>
<th>Type</th>
<th>Percentage</th>
<th>Type</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abrasions</td>
<td>50.0</td>
<td>Upper extremity</td>
<td>43.2</td>
</tr>
<tr>
<td>Contusions</td>
<td>11.4</td>
<td>Lower extremity</td>
<td>27.3</td>
</tr>
<tr>
<td>Lacerations</td>
<td>11.4</td>
<td>Face</td>
<td>11.3</td>
</tr>
<tr>
<td>Fractures</td>
<td>11.4</td>
<td>Head or neck</td>
<td>11.3</td>
</tr>
<tr>
<td>Concussions</td>
<td>9.1</td>
<td>Torso</td>
<td>6.8</td>
</tr>
<tr>
<td>Dislocation</td>
<td>2.3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Strain</td>
<td>2.3</td>
<td></td>
<td></td>
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<tr>
<td>Puncture wound</td>
<td>2.3</td>
<td></td>
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</tbody>
</table>

**Figure 2** Injuries encountered in mountain biking accidents by type and location (18).
Soft-tissue Abrasions, Lacerations and Contusions

The most common type of non-severe injuries encountered during mountain biking accidents and other extreme sports in the wilderness are abrasions, lacerations and contusions (60-75% of injuries) (17). Although these injuries are non-fatal and do not usually need transportation of the athletes, self-reported injuries can burden hospital resources. Most of the more serious injuries occur on the extremities and while falling sideways on the bicycles at higher speeds (21). However, if these injuries immobilize the athlete and a rescue team is sent out, first aid is usually adequate to treat these patients and transportation to a facility is not dependant on time.

Orthopedic Injuries

The most common bone broken on mountain biking accidents is the clavicle (17). However, more serious and incapacitating injuries involve the head and face, cervical spine and fractures of the upper and lower limbs. Even though helmets reduce the risk of injuries, 13% of sport-related head injuries presented to the emergency department are from bicycling accidents (22). Bicycle helmets have been shown to reduce the risk of head injuries by 39% and the risk of facial injury by 28%. 55% facial traumas involve fractures of the bone, where 15.2% resulted in maxillary fractures (23). Dental traumas are also common during a frontal fall (24) and thus there is an increase trend of wearing facial guards, especially with downhill bikers.

Cervical spine injuries are usually associated with over-the-handlebar injuries. The cervical spine is the most common site of injury to the spine and cord injury is usually left undiagnosed. Both flexion and hyperextension injuries can occur depending on the physics of the fall (25). Aspingi describes three case reports where mountain bike accidents have left athletes paraplegic. The riders in these case reports have either fallen over the handlebars or have fallen directly on the helmet (19).

Although most limb injuries fall under the category of soft tissue lacerations, there are several distinctive fractures involved with bicycle injuries. 35% of the time, the radial head is broken, most probably due to trying to stop the fall with outstretched hands. The other two bones that are commonly broken are the distal radius (30%) and the scaphoid (28%) (26). Lower limb fractures are now due to heavy contact with the ground due to delayed unclipping of the foot from the pedals. The most common bone to break is the fracture of the femoral neck (27) or acetabulum due to a direct blow to the hip (28).

Myocardial Infarctions and Internal Injuries

Extreme sports are demanding to the body and due to the increasing trend of mountain bikers, there is a risk of myocardial infarcts. According to Ortega, the amateur mountain biker can induce injury to the heart. This was determined by measuring plasma urea, creatinine, creatine kinase, myoglobin and cardiac troponin I concentrations the day before and immediately after a 95 km mountain bike challenge. Although all the enzymes were elevated, the cardiac troponin I concentrations were still below the threshold (0.5 μg/L), indicating sub-clinical damages (20). The average mountain bikers, however, are not at the level of
amateur bikers and will obviously have a higher strain on their physiology, thus
posing a higher risk for injuries. The risk of having a myocardial infarction while
doing extreme sports remains undetected however, because of the nature of the
injury (29).

Myocardial infarctions pose a great problem for the rescue teams because of the
time sensitivity of the injury. For even mild infarcts, the need to transport patients to
a tertiary health care center for intervention needs to be within the ‘golden hour’ after
the onset of pain (12). Most response times to reach the patient are around 30
minutes, leaving only 30 minutes to get the patient to the cardiac ward for
emergency care. According to Aleraj of the GSS, most patients who have had
myocardial infarcts in the wilderness settings have died due the response time of first
aid (13).

Another serious and relatively common injury in mountain biking is internal injury due
to blunt trauma with the handle bar on a frontal collision. The spleen is the most
common injury (49%) followed by the liver (15%) (30). Internal hematoma, especially
of the spleen, is a medical emergency and needs to be recognized and treated
immediately. The ‘golden hour’ rule may not apply with internal bleeding and
eventual shock. Osterwalder has shown that the mortality with patients treated
within the first 60 minutes is 14% with compared with patients treated after 60
minutes (10.2%). However, North American trauma surgeons believe that
stabilization in the field will still reduce mortality rates for patients with blunt
polytrauma (31).

**Better to Provide More Care?**

Having a medical doctor, who is able to diagnose, improvise and extend the ‘golden
hour’ for myocardial infarctions with specialized equipment made for onsite care, on
the rescue team would be beneficial for the patient. For polytraumas, a medical
doctor can stabilize the patient better than volunteer paramedics before transport to
a health care facility with more adequate diagnostic equipment and treatment
options. In a study done by Lossius, there is a significant benefit of having a
physician on an emergency medical team measured by life years gained (LYG). 88% of the 504 LYG in 74 patients in the study were attributed to having an
anesthesiologist on the EMT (32). Fowler also suggested that by having a medical
doctor on the EMT or a rescue team, the doctor can better discriminate the
management of patients with major trauma and can improve outcomes (33).

Although there are many types of equipment out there, there is no standardized
equipment list made for mountaineering rescue teams (4). This is probably because
of the difference in terrains in peripheral areas. Thus, most rescue teams are
sometimes supported by the military, which may have the transport equipment, but
not medical knowledge to support the patient with more than just advanced first aid
(13). An example of novel rescue equipment that should be standard in any rescue
team would be the Subaru’s Mountain Rescue Vehicle (MRV). This type of MRV is
able to transport patients and provide advanced care onsite (34). With the
accompaniment of a medical doctor, remote health care can be more advanced and
the ‘golden hour’ can be extended.
Conclusions
Thus assigning medical doctors trained in wilderness transportation techniques to mountaineering rescue teams will not only enforce standardized training and education with medical chambers or associations to handle difficult situations for stranded patients, it will also enable patients to have better health care with novel medical equipment designed for tertiary care in remote areas.

It is difficult to compare the need for equipment and the mortality rates if the equipment is available because of the difference in situations and injuries, but there is a need to provide better health care in more remote areas when transport takes longer and tertiary health facilities are too distant for emergencies. The creation of a rescue team with a permanent medical doctor would in theory decrease the mortality of athletes and other patients found in remote or peripheral areas.

Acknowledgements
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References


List of Abbreviations

1. Mountaineer Area Rescue Group (MARG)
2. Appalachian Search and Rescue Conference (ASRC)
3. Gorska Služba Spašavanja (GSS)
4. Wilderness Emergency Medical Services Institute (WEMSI)
5. Life Years Gained (LYG).
6. Mountain Rescue Vehicle (MRV)

Corresponding Authors

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