Wilderness Medicine Institute of NOLS

Evidence Informed Wilderness Medicine

What Really Happens Out There?

Tod Schimelpfenig, Curriculum Director
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Executive Summary

What really happens out there? In the context of general outdoor recreation, hikers, trekking, and outdoor education the data are consistent. Serious trauma is rare. Sprains, strains and minor soft tissue wounds are common. Serious illness is rare. Nausea, vomiting, diarrheal and flu-like illness are common; although we do bring our medical history with us into the woods.

If you paddle expect to see more upper extremity injuries, and if you go to altitude expect to see altitude illness. If you work in a national park or a front country recreation context you might see more chronic medical problems from your visitors. If you work in a dedicated search and rescue (SAR) unit more of your responses may be for serious injury and illness; those with sprains and strains and minor illness may self-evacuate.

In hot weather you may see problems due to heat and hydration, in cold weather you may see hypothermia and frostbite. It is surprising that these are not more common in the data, perhaps due to awareness and prevention on guided and the outdoor education trips.

Thus the burden of wilderness medicine; to be prepared for the common, the athletic and soft tissue injury and the gastrointestinal and flu-like illness, as well as the more rare but serious injury or illness.

Introduction

Is wilderness medicine a heroic medical intervention in an austere setting? Is it managing blisters, diarrhea, nausea and vomiting while leading an expedition or working at a remote clinic? Are people keeling over left and right from altitude illness and heat stroke? Is Giardia epidemic in backpackers? Do we need to know how to suture wounds or reduce a dislocation, or are the key practices as simple as hydration and hygiene?

This article looks at the research with interest and caution, using the honest phrase "evidence-informed" rather than "evidence-based." Answers will be elusive, influenced by the hat we wear when we practice our medicine – search and rescue, outdoor program leader, park ranger – and by the quality of the research. Science is our guide, but experience and human bias mould our choices. A memory that has changed over time or an experience that left us an emotional hook can lure us down the road to anecdote-based medicine.

The context of the practice of wilderness medicine includes outdoor recreation, remote expeditions, rural clinics, disaster response and even aerospace medicine. This review has a narrower focus, looking mostly at people recreating in the outdoors.

I've sorted these studies into adventure education (which includes the NOLS data), surveys of long distance hikers, summer camps, SAR data (which includes studies from National Park EMS systems), adventure racing, and focused reviews of specific topics such as altitude illness and animal attacks. I'll conclude with a summary of what all this may mean, and the implications for our curriculum.

The NOLS Data

The NOLS Field Incident Database is the largest set of injury and illness reports from wilderness educational expeditions. It is currently in its 30th year with over 4 million person days of experience and 14000 incidents. The first paper - there are now three reviews and several other focused reports generated from the database - has been called the sentinel publication on wilderness injury and illness. [1], [2], [3]

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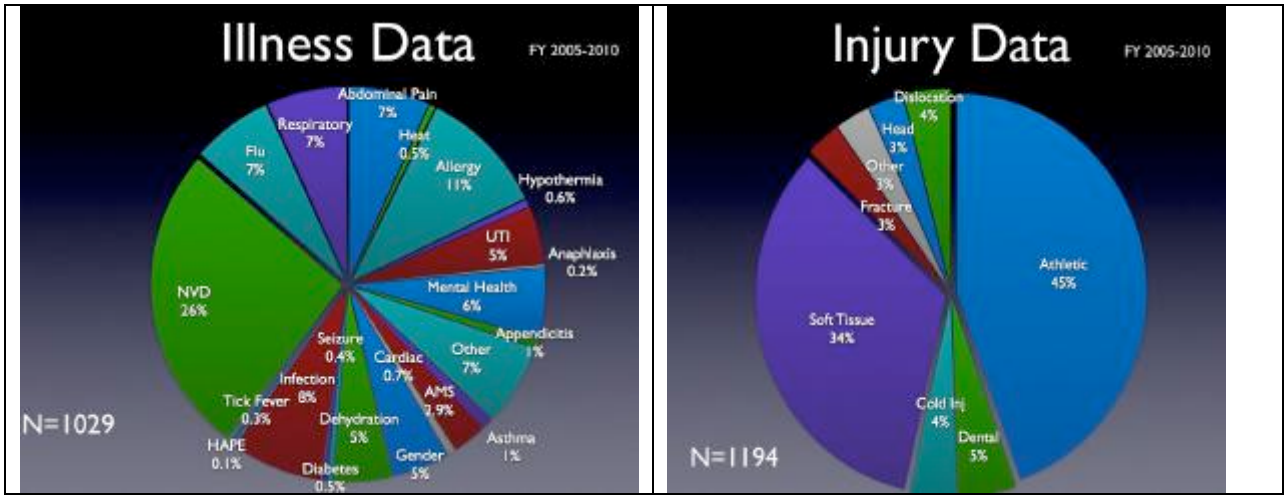
To give you a sense of the data, in an average year NOLS experiences:
450 Reported Incidents
330 Medical
180 Injuries
150 Illnesses
140 Field Medical Evacuations
6 Helicopter Evacuations



Notice what doesn't make the top ten list: dehydration, hypothermia, heat illness, non-freezing cold injuries, frostbite, snow blindness, HAPE and HACE. These are prevented through fundamental outdoor skills competence and leadership. They rarely reach the threshold for a reportable incident. Noticeably absent are ballistic injuries; mechanisms such as long falls and skiing into trees. Instead, we see overuse injuries and small wounds. The spectrum of medical problems includes illness that would occur regardless of whether we are in the wilderness or the city such as manifestations of asthma, diabetes and urinary tract infections, and illness that is likely hygiene-related; nausea, vomiting, diarrhea and flu-like signs and symptoms.

The NOLS data provides an important snapshot of the medical experience on educational wilderness expeditions, but it needs to be viewed in the context of a NOLS expedition. NOLS staff focus on prevention, are trained to at least the Wilderness First Responder (WFR) level and are carefully selected, trained and mentored as they lead these wilderness expeditions.

Data from Outdoor Adventure Programs

There are other, albeit smaller data sets from outdoor adventure programs (Widiwagen, a large YMCA camp in Minnesota and Outward Bound) that show an illness and injury picture consistent with the NOLS data. [4] [5] [6] The Wilderness Risk Managers Committee, a consortium of outdoor adventure programs, published data it gathered from a broad spectrum of outdoor programs.[7]

Top Five Medical Incidents – Outdoor Adventure Programs			
Widiwagen (2003	OB (1992)	COBS (1995)	WRMC (2004)
Athletic	Laceration	Laceration	Athletic
Laceration	Bruise	Blister	Soft Tissue
N/V/D	N/V/D	Bruise	N/V/D
Burn	Burn	Burn	Flu-Like
Puncture	Athletic	Athletic	Abdominal Pain

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There is data from backpack and canoe trips in Adirondack Park consistent with the experience of other adventure programs.[8]

Reported Medical Problems Scout Trips - Adirondack Park		
	#	%
Blisters	19	30%
Wounds	18	29%
Burns	5	8.0%
Headache	4	6.5%
Abdominal Pain	2	3.0%
Ankle Sprain	1	1.5%
Contact dermatitis	2	3.0%
Dehydration	1	1.5%
Hypothermia	1	1.5%

Surveys of Trekkers and Long Distance Hikers

Buddha Basnyat, medical director at the Nepal International Clinic in Kathmandu says that for trekkers in the Himalayas gastroenteritis is more common than altitude sickness. Pharyngitis/bronchitis was the common illness (12%) followed by acute mountain sickness (8%) and gastroenteritis (6%). Illness caused by infections comprised 33% of the medical problems. This same pattern is seen in studies of illness to hikers in India, Nepal and Africa. The prevalence of gastrointestinal illness in the local population, interactions with these people and poor hygiene habits in the trekkers probably contribute to this illness pattern. [9]

Long Distance Hikers

Studies of long distance hikers in North America, all small after the fact surveys, are interesting snapshots of wilderness medicine. One survey of 280 backpackers generated a medical complaint list of foot blisters, diarrhea, skin irritations and acute joint pain. The risk of diarrhea was greater among those who frequently drank untreated water from streams or ponds, whereas practicing "good hygiene" (defined as routine cleaning of cooking utensils and cleaning hands after bowel movements) was associated with a decreased risk. [10]

Another survey of 180 Appalachian Trail thru-hikers found that 82% reported an injury or illness (25% of these interrupted their hike to seek medical attention), 62% reported an athletic injury, 17% reported soft tissue injury, 26% (1 in 4) reported gastrointestinal symptoms, 63% had at least one episode of diarrhea and 10% reported an upper respiratory tract infection. [11] A third survey, this one of Long Trail hikers, generates the now familiar list of athletic injuries, blisters and gastro intestinal complaints.[12]

Illness and Injury Among Long-Distance Hikers The Most Frequently Reported Conditions		
Long Trail Hikers	**Appalachian Trail Hikers**	**Appalachian Trail Hikers**
Athletic	Blisters	Athletic
Blisters	Diarrhea	Gastrointestinal
Miscellaneous	Skin irritations	Soft tissue
GI	Acute joint pain	Upper respiratory infection
Minor Trauma		

Summer camps

There were 12,000 summer camps in the USA serving 11 million children in 2002. Many of the camps use Wilderness First Aid or Wilderness First Responder as medical training for their staff. The American Camp Association (ACA) is undertaking a multi-year study of health and safety at camps in their "Healthy Camp Study." The data is available on the web. [13]

Communicable diseases (classified as stomach flu, aches, sore throats and fever) accounted for 32% of day camp illnesses among campers (33% for staff) and 40% of resident camp illness among campers (51% for staff).

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Common injuries for both day and resident camps include the familiar lists: broken bones, head injuries from falls, and sprains or strains, bruises, and wounds.

Head injuries accounted for 41 percent of the injuries to day campers. This data appears alarming, but only 15% had indications of a concussion. Blows to the head seem common in these young campers, and the ACA notes a need for a solid foundation in head injuries and wound management in the staff's first aid training.

Everest ER

The clinic at Everest base camp sees an interesting mix of trekkers, climbers and local inhabitants. Medical complaints were 85%, injuries were 14% of diagnoses. Pulmonary causes such as high altitude cough and upper respiratory infection, comprise 38% of medical diagnoses. These are disproportionally seen in the local inhabitant subset, probably due to long term poor health care and living conditions. For traumatic diagnoses, 56% were for dermatologic causes, most commonly frostbite and lacerations. The study concluded that medical professionals treating patients in this context should have a broad scope of practice. [14]

Categories of medical diagnoses seen at the EverestER, 2003–2012[15]

Diagnosis category	Number	Percent
Pulmonary	1164	38.2
Gastrointestinal	480	15.8
Ear, nose, throat	439	14.4
Neurology	199	6.5
Musculoskeletal	144	4.7
Constitutional	139	4.6
Dermatology	106	3.5
General	81	2.7
Dental	70	2.3
Eye	51	1.7
Cardiovascular	50	1.6
Psychiatric	42	1.4
Genitourinary	40	1.3
Allergic/immunologic	15	0.5
Endocrine	13	0.4
Toxicology	11	0.4
Hematologic/lymphatic	1	0
Total	3045	100

Categories of traumatic (injury) diagnoses seen at the Everest ER, 2003–2012

Diagnosis	Number	Percent
Dermatology	280	56
Musculoskeletal	175	35
Eye	22	4.4
Dental	12	2.4
Neurology	7	1.4
Ear, nose, throat	3	0.6
Pulmonary	1	0.2
Total	500	100

SAR Data

The reports for SAR groups capture people on personal trips rather than organized adventure programs. The lack of a coding system for factors such as distance from the trail head, specific activity at the time of the incident or weather is a limitation to this data. As well, some of the data select only for serious incidents as compared to the outdoor program data's perspective on minor injuries and illness. All of the data is subject to reporting biases, especially in determining the number of people and the number of days of exposure. In many cases we know who got hurt, but we don't know who didn't get hurt, or who simply walked by the trail register without bothering to sign.

The data is influenced by where it was gathered. Trauma from falls may be found in data from a mountainous area, but it won't be on the list at Everglades National Park where the high point is 6' above sea level. In the southwest heat illness will be more common. In the northeast hypothermia and frostbite are prominent. Close to major population areas we may see more heart attacks and other medical problems.

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One frequently cited study, used to report that half of all wilderness deaths involve alcohol intoxication, is really a look at incidents in state parks and national forests surrounding a major metropolitan area, an account of the good old boys at the quarry, not a wilderness expedition. [16] [17]

We also need to learn what a person was doing when they became a statistic. Did they fall off a steep trail in the Grand Canyon or over the railing at a roadside vista while taking a picture? Was their heart attack from heart disease or precipitated by heat stress in the desert. Despite all these caveats, there are lessons to be gleaned from the available SAR data. [18],

A retrospective review of 467 New Hampshire Fish and Game Department wilderness search-and-rescue reports is worth a read. [24] These are people who were hiking, walking, climbing, cross-country skiing, backcountry downhill skiing, hunting, snowmobiling, all-terrain vehicle use, boating, canoeing, or fishing in the wilderness. [19]

Illness is not a common cause of overall responses but hidden in the details is the data that 24% of the fatalities had cardiovascular causes. The mean age of these poor souls was 56.

SAR Responses in New Hampshire – Injury Profile	
Fractures	33%
Sprains	18%
Wounds	18%
Hypothermia	9%
Frostbite	3%
Head injury	3%
Other	13%

A set of data from Washington State focused on deaths to younger people (between 12 months and 20 years of age) recreating outdoors. [25] It's a stretch to call many of these incidents wilderness incidents, yet the profile is interesting. The most frequent injury leading to death was drowning (55%) followed by closed head injuries (26%). Although 4 (80%) of the 5 deaths among children younger than age 10 were by drowning, none in this age group intended on being in the water (2 children drowned after falls into water from boats, and 2 children drowned while playing or camping near water). Among the 21 non-scuba drowning cases, none of the victims was wearing a life preserver, and only 1 had a life preserver nearby at the time of death. None of the victims in this study was alone. Teenagers were usually with peers and younger children were with adults. [20]

National Parks

A set of studies of emergency medical services in western national parks are perspectives of medical services in parks and echo themes from the adventure program data. In one study 70% of injuries were musculoskeletal or soft tissue, 35% involved the lower limbs (ankle and knee) and 27% the upper limbs (hand and wrist). Illness was spread through multiple categories ranging from cardiac, through diabetes and seizures to anaphylaxis and vaginal bleeding. No one category stood out except cardiac, which accounts for a number of the fatalities. Here is a snap shot of a population with a different age profile than the adventure programs, people who have history of heart and lung disease, diabetes and other medical problems. It speaks to the relevance of the medical topics in wilderness medicine curriculum. [22,23, 24 25 26]

Recreational Wilderness Injuries, Mount Rainer and Olympic National Parks [21]	
Sprains, strains and soft tissue injuries	28%
Fractures or dislocations	26%
Lacerations	15%
Closed head injuries	5%
Multiple traumas without closed head injury	5%
Hypothermia or frostbite	4%,
Insect stings	3%.

Schussman and Lutz reviewed 108 climbing accidents in Grand Teton National Park. As expected the mechanism of injury is primarily falling on rock or snow (60%). The dominant injury is a fracture, followed by soft tissue injury and athletic (strains and sprains) injury. Episodes of "massive trauma" were invariably fatal. [27,28]

A paper from Yosemite National Park surveys climber injuries, both those who walked into the clinic and those who needed rescue. Here the majority of injuries are mild to moderate; fractured or sprained ankles, fractured tibias and multiple abrasions. A prominent cause of the fatalities in this study was head injury or multiple trauma from falls.[29], [30]

A study of canyoneers in Zion National Park described soft tissue injury and fractures as most common, but few of these required evacuation. Several of the respondents to this survey reported lower extremity sprains once every 3-4 years during their wilderness trips. [31]

Denali

Denali National Park published a study of their SAR responses that has a look at the medical complaints they experience.[32]

Chief complaint of general medical SAR cases Denali 1990-2008		
	Number	%
Fatigue	13	28.3
Abdominal paina	10	21.7
Cardiac/chest pain	7	15.2
Gastrointestinalb	5	11.0
Respiratory	3	6.5
Seizure	2	4.3
Eye pain	2	4.3
Leg pain	1	2.2
Sudden fatal collapse	1	2.2
Syncope	1	2.2
Blurred vision	1	2.2
Total	46	100

Incidences of cold and high altitude afflictions as primary reason for SAR		
	Number	%
Frostbite	41	40.3
HAPE	30	29.4
HACE	10	9.8
HACE & HAPE	9	8.8
Hypothermia	8	7.8
AMS	4	3.9
Total	102	100

A paper on the Yellowstone Park experience shows a familiar injury profile. [33]

Injury Types Requiring Emergency Medical System Activation		
	Number	%
Strain, sprain, soft tissue injury	105	34.3
Fracture, dislocation	27	8.8
Laceration, abrasion, burn	132	43.1
Environmental injuries/exposure	18	5.9
"Other miscellaneous trauma"	24	7.9
Total	306	100.0

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Shenandoah National Park

The pattern of illness and injury trauma seen in Shenandoah is consistent among several geographically different national parks in the United States. Among adult visitors, the most common medical complaint was chest pain, a complaint more prevalent at Shenandoah National Park compared to other parks. [34]

Injury type	Number	%
Soft tissue	10	34.5
Laceration	8	27.6
Sprain	3	10.3
Dislocation	0	0.0
Fracture	3	10.3
Burn	2	6.9
Snakebite	2	6.9
Loose teeth	1	3.4

Anatomic location	Number	%
Proximal lower extremity	2	6.9
Distal lower extremity	8	27.6
Proximal upper extremity	3	10.3
Distal upper extremity	6	20.7
Back	0	0.0
Chest	1	3.4
Head/neck	9	31.0

Medical illness by presenting complaint	Number	%
Chest pain	9	15.8
Dizzy	7	12.3
Diarrhea	1	10
(Respiratory distress insect sting/bite)	5	8.8
Seizure	5	8.8
Short of breath	4	7.0
Palpitations	3	5.3
Nausea and/or vomiting	3	5.3
Rash (insect sting/bite)	3	5.3
Syncope	3	5.3
Asthma exacerbation	2	3.5
Heat exhaustion	2	3.5
Intoxication (alcohol)	2	3.5
Medication side effect	2	3.5
Respiratory distress(non insect)	1	1.8
Dehydration	1	1.8
Hyperhydrosis	1	1.8
Pain (no trauma)	1	1.8
Pregnancy	1	1.8
Weakness	1	1.8
Headache	0	0
Rash (noninsect)	0	0
Total	57	

Wild ALS

Recommendations on which ALS practices are helpful in the wilderness context are based on limited experience, most of it in a classroom or training setting. The published evidence on this topic is limited. One retrospective review of SAR reports, this one from Canada, shows that of 272 cases, 56 required ALS (7 oral airways, 5 MAST pants, 2 CPR, 41 medication administrations, 1 urinary catherization). [35] [36]

A retrospective observational analysis of 114 SAR missions in the Mt Hood Region of Oregon gives us another profile of an injury pattern. [37]

CPR, splinting, spine immobilization and oral airways are BLS skills. Looking at the specific ALS procedures of IV access and fluids, medications, intubation and urinary catherization I can only conclude that these are unusual, if not rare.

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It's difficult to make much sense of these snapshots of ALS in the wild experience. Was the ALS performed by a ground SAR team or by a helicopter crew? Were these interventions medically necessary? How many were maintained for any length of time in the wilderness?

ALS Procedures on SAR missions from 89-94 in the Mt Hood Region	#	%
Intravenous Access	52	23%
Spine Immobilization	42	19%
Splinting	40	18%
IV Fluid	40	18%
Morphine	24	11%
Inaspine (Anti N/V, tranquilizer)	13	6%
Intubation	8	4%
Succinycholine	4	2%
CPR	2	1%
Mannitol	2	1%
Needle Thoracostomy	0	0%
	227	100%

Adventure Racing

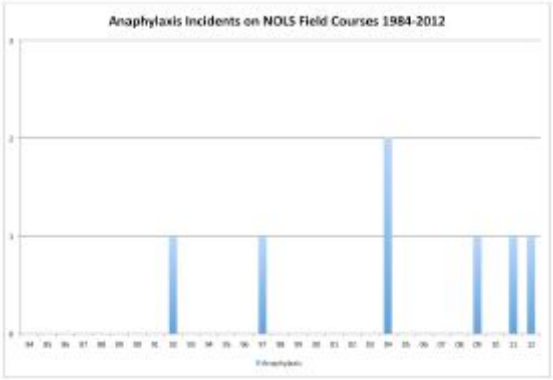
There are several studies of adventure racing that give us an anticipated injury profile. The dominant injuries were soft tissue and athletic, the locations lower extremity (especially feet and ankles) and wrists. [38], [39]

Hunters

In a study of hunters in western Colorado 45% had injury, 31% illness and 24% "other problems" that prompted them to visit the ED. The most common illness, and the cause of all the fatalities was cardiac. Lacerations were the most common injury.[40] A study from Wisconsin has similar patterns, although the use of tree stands reflects more reported fractures, and falls as an important mechanism of injury. [41]

Published Data On Specific Wilderness Medical Problems

We can also look at published data on specific wilderness medicine problems. The possibility of anaphylaxis generates much angst among wilderness trip leaders, yet the incidence of anaphylaxis from any cause, let alone bees, is elusive. [42, 43, 44]



Bears kill less than one person a year in the US, and alligators, cougars and bison share this statistic. [45] Lightning is the cause of an average of 88 fatalities a year (23 in 2013). [46] Snakes bite an average of 5000 people a year in the US. Very few of these snakebites are in the wilderness and very few of the victims die. Hypothermia and heat stroke kill several hundred people a year, primarily in urban areas. The most prominent killer is drowning, a common cause of death in the outdoors. The studies on altitude illness show us that AMS is common, HAPE and HACE rare. AMS at ski areas in Colorado reportedly affects 22% of visitors, and among Nepal trekkers 45% suffer s/s of AMS. [47]

Whitewater Kayaking

A review of studies of injuries in whitewater kayaking and rafting shows that acute injuries in kayaking are usually due to the transferred force of the water on the upper extremity, most often the shoulder, or impact on an object while "swimming." Acute rafting injuries are more often due to contact with another rafter's paddle or other equipment, or the rafter hitting an object while "swimming." Chronic injuries are uncommon in rafting but account for 25% to 40% of all kayaking injuries, most often either shoulder or wrist complaints. This is consistent with the experience of any river guide, who knows the shoulder dislocation and wrist strain. [48, 49, 50]

Sea Kayaking

The majority of respondents to surveys of health problems while sea kayaking said injury was uncommon and often not serious. Sprains, pulled muscles, cuts and abrasions were most often reported. [51]

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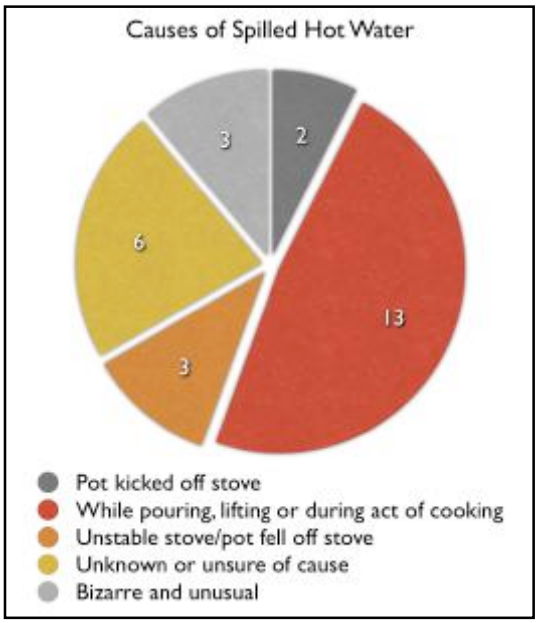
What does this mean to our curriculum?

We use this evidence and our experience to inform our curriculum. The spectrum of injury and illness is broad, from the common to the rare, from uncomfortable to life threatening. Common are sprains and strains, small wounds, burns, blisters, and nausea, vomiting, diarrhea and flu-like illnesses. The well-prepared wilderness medicine provider is ready to manage these on a daily basis. Hopefully they will only practice for, and never experience, major trauma.

Prevention is essential as an educational theme. Nausea, vomiting, diarrhea and flu-like illnesses are likely related to hygiene, living close together, stress and fatigue. The Centers for Disease Control surveyed climbers on Denali in Alaska in response to reports of diarrhea. They found that 29% of climbers had diarrhea at least once on the mountain. Less than half of the climbers said they habitually washed their hands after defecating and 25% confessed to never washing their hands. A disgraceful 11% confessed to pooping directly into the snow near their camps, not in a crevasse or in a poop pail as suggested by the park service. [52] The authors recommended people on these popular routes be educated on communicable disease and hygiene, disinfect their water, wash hands after a bowel movement and certainly before meals. They noted the effectiveness of alcohol-based hand sanitizers. [53] [54]

At the same time, there is an ongoing discussion in wilderness medicine on the need to disinfect water. [55] [56] [57] [58] [59] [60] [61] [62] [63] People venturing into the wilderness need accurate information to make informed rational decisions on the need for water disinfection. [64]



The NOLS data clearly shows that the cause of most of the **burns** is spilled hot water. The cook pot is the primary source of contained energy that can cause a burn; be organized and careful around the kitchen.

Wound infections, a problem in the past at NOLS, have been declining since 1989.[2,3,4] We believe this is due to better awareness of the potential for wound infections and training in wound cleaning and management.

Athletic injuries (sprains, strains, tendonitis) are a constant challenge seen in multiple studies. Prevention needs to focus on pre-trip fitness, carefully planning course routes, emphasizing warming-up and stretching before hiking and strenuous activities, deliberately teaching students how to hike on rugged and uneven terrain and avoiding gargantuan packs. Management in the field is limited to assessment for usability, the common evacuation decision point, ice, pain management and support.

Fractures and dislocations are uncommon. Splinting is a simple, practical skill that can provide great comfort to the patient. Several studies on location of common fractures confirm our focus on simple wrist and lower leg splinting. Anecdotal support that laypeople can reduce common dislocations, anterior shoulder and patella, with low risk of harm is abundant, evidence is sparse. Unpublished NOLS data shows that shoulder dislocations are reduced 85% of the time in the field and without complication.

37% of the illnesses and 49% of the injuries in the NOLS data were evacuated, only a very few were hospitalized. Wilderness evacuations are driven in part by the inability of an expedition to wait patiently while a patient recovers from an injury or illness, and they are driven by a concern that this problem, especially illness, is beyond the ability of the leader to evaluate. Leaders, often people with extensive outdoor but limited clinical experience, need to be prepared to make **decisions** on whether a patient needs to be evacuated for a physician's evaluation and if so, with what urgency.

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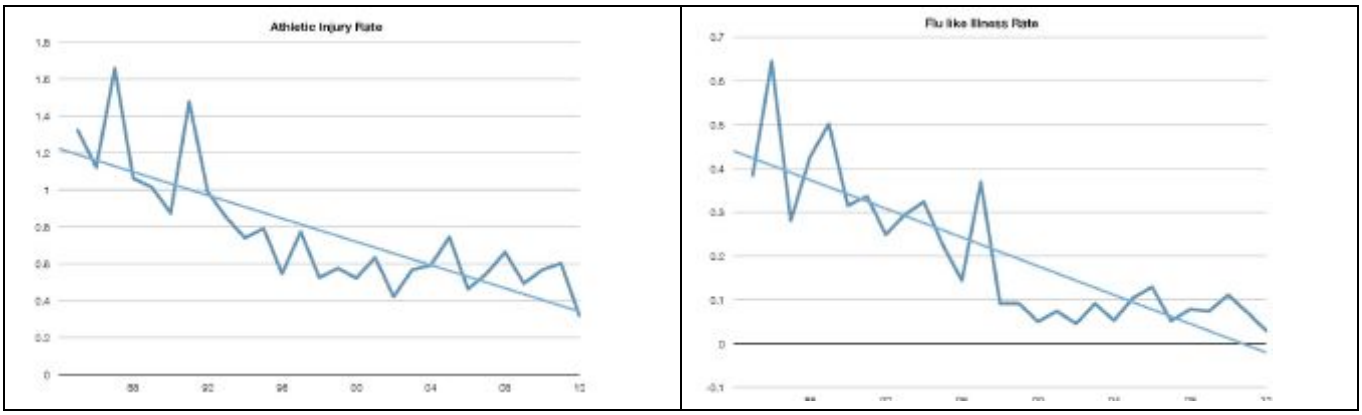
Medical topics are relevant to wilderness medicine curriculum. Illness with history will present while on an expedition, and illness without history will reveal itself for the first time. Even cardiac disease, far from the radar screen of the young healthy people in many outdoor programs, is seen in the data. [65] A wilderness medicine provider needs to be familiar with a range of medical problems (flu-like, respiratory, diabetes, cardiac, altered mental status, urinary tract infection, vaginitis, testicular pain) which can present in remote circumstances. However, what is practical is not diagnosis but rather prevention, initiation of reasonable and prudent field management and identification of red flag signs and symptoms necessitating evacuation for potentially life-threatening problems.

Hypothermia, heat and altitude illness are less frequently reported in the outdoor data sets, yet the environmental injury and illness curriculum must be addressed. We know they are a constant threat and we work hard at prevention.

Head and spine injury show up in all the data, albeit more in the SAR data. The NOLS data shows that a selective spine immobilization decision is made 3-4 times a year. This is an important assessment skill for people in remote environments and the experience suggests it's done conservatively and cautiously. As well, remembering the data from the ACA, the prepared leader needs to know what to do when someone hits their head. If you talk to outdoor leaders you find this decision, along with evaluating abdominal pain, are the most vexing for the lay provider,

Does it help?

The literature lacks longitudinal studies evaluating the effect of training on the medical care on wilderness trips. However the NOLS database shows clear trends of a reduced evacuation rate and reduced incidence of athletic injury, wound infection and hygiene related illness. We learned what is common and we've educated staff on their prevention and management.



The rate of athletic injury and flu-like illness on NOLS courses 1984-2012

Does wilderness medicine education make a difference? Absolutely. Those of us who were in the field in the early days of modern outdoor education remember the inconsistent and sometimes inappropriate care we practiced, and have the perception that our standard of care has risen. Our medical training has better focus on what is relevant and practical and has discarded much that was interesting and exciting, but irrelevant and impractical.

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