Psychological and Psychophysiological Factors in Prevention and Treatment of Cold Injuries

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"MAN IN THE COLD IS NOT NECESSARILY A COLD MAN." (LeBlanc)

Prolonged exposure to snow, wind, water, and/or altitude in cold temperature environments has long been recognized as the critical stressor accounting for most cold injuries. Cold can produce permanent physical and functional losses due to frostbite or fatal effects from hypothermia. When unprotected human tissue is subjected to extended or extreme cold exposure, there is an increased potential for disrupting several physiological functions and creating permanent anatomical damage as when true freezing occurs (2-5). Although extreme environmental conditions and the natural biological limitations of homothermic organisms alone are sufficient precursors to cold injuries, certain "biopsychosocial" variables increasingly account for the greatest incidence and severity of injury (6).

The curious and perplexing nature of individual differences across cold environments provides an interesting challenge for understanding psychological and physiological adaptive responses to cold. Experiences cited by pioneer polar explorers often conjures images of heroic challenges of incredible and remarkable journeys against seemingly impossible odds in the face of cold weather survival. Documented accounts of legendary military battles staged in cold environments have reported on the tragic consequences sustained by many cold casualty field troops (7). Popular entertainment films and the media have also recently rediscovered that cold survival stories sell. Contemporary films like "Alive" and "K2", and the recent news reports of a frostbitten couple with an infant stranded for days in a Nevada snow storm, all perpetuate cold fear as part of our national consciousness. Extraordinary experiences in the cold, wartime cold trauma, and controlled cold research studies will continue to increase our search for knowledge about preventing injuries as well as developing methods to maximize human performance in cold environments.

This article reviws research on contributory risk factors, behavioral responses, and clinical issues associated with cold injury. The article briefly summarizes cold research issues for injury profiles, psychological responses, and sport applications. The review also examines applied psychophysiology and medical psychotherapy as supportive treatment methods for cold related vascular disorders. Specifically, thermal biofeedback training is highlighted as a clinical strategy in the treatment of frostbite, Raynauds and other cold induced vasospastic disorders. Most research contained herein represents several years of collaborative efforts with scientists, clinicians, students, sports enthusiasts, athletes, and patients in Alaska. It is with great respect and gratitude that we express appreciation and recognition to the many Alaskans who have made contributions to these studies.

COLD RESEARCH METHODS

Cold research is conducted under a variety of conditions in natural, as well as artificially created cold environments, and is usually denoted by activity for sport or work. Indoor cold research methods can include a "cold pressor" test to evaluate psychophysiological responses. Experiments typically require extremities to be submersed in cold water under precise laboratory conditions. This technique challenges the limits subjects can endure experimentally induced cold pain. Cold pain tolerance is tested by having subjects or patients place their hands in ice water at 32 degrees F. (8). Other indoor studies have included whole body exposure to cold temperatures in environmentally controlled chambers or whole body immersion in cold water (9).

Outdoor field studies have carefully observed subjects immersed in cold water lakes with survival suits (10), or swimming in open seas (11) (i.e. Bering Strait five mile swim by Lynne Cox (see figure 1). Most outdoor cold research protocols maintain active monitoring of

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subject's vital internal and external physiological processes which include simultaneous behavioral observations. Such methods provide necessary protection and safeguards since medical personnel are immediately available and familiar with critical physiological limitations. These research protocols afford further safety since subjects constantly have the freedom to immediately terminate or withdraw without penalty. This tethered approach is quite different from naturalistic outdoor cold field studies where subjects freely choose to expose themselves to cold risk hazards. Subjects participating in amateur and professional sports, scientific expeditions, or outdoor professions perform with or without extensive safety considerations. Some cold researchers volunteer to serve as their own subjects. This has occurred with major international expeditions to Anarctica (12) and with local research expeditions on Mt. McKinley, Alaska (13).

The least controlled yet no less valued cold research data comes from "ex post facto" studies. These clinical studies represent data from hospitalized patients who have sustained cold injuries and retrospectively report on the events they perceive lead to injury. The inarticulate or confused patient frequently necessitates clinical inference built on estimating the probable sequence of factors responsible for injury. The data often suggest that most tragic consequences were preventable or, perhaps, could have been minimized if only precaution and good judgment had prevailed.

Research in industry and the military has long recognized that effective cold work performance requires a substantial increase in number of work hours. This results in a significantly longer time "labor factor" difference between winter versus summer working conditions. Indoor or outdoor research usually measures manual performance, dexterity, physiological body cooling, and thermal comfort during work. Comprehensive performance indicators usually include: tactile sensitivity, hand skin temperature, visual motor tasks, reaction time, mental tasks and perceptions during various cold exposures. Evidence supports increased psychological adaptation with repeated cold exposure, but does not appear to demonstrate significant or sufficient physiological acclimatization. Workers seem to tolerate cold conditions better with less pain and inconvenience after repeated experience in cold. Psychological adaptation to thermal discomfort, while desirable, may inadvertently pose greater risk of injury by further diminishing reliance on normal warning mechanisms for physiological cold stress (14).

Outdoor cold research in Finland has also studied physiological limitations over psychological adaptation by examining frostbite frequency for northern climate reindeer herders. These workers were found to exhibit greater incidence of cold injury regardless of age, years smoking, or years of experience in cold work. The hours of snowmobile use, previous reports of "white finger" (Raynaud's predisposing symptoms), and work in the most northern regions were found to be statistically related to the greatest percentage of frostbite injury. The results also indicated prevailing wind chill index coupled with snowmobile activity was responsible for a fivefold increase in frostbite frequency. Apparently, the combined effects of wind, vibration, and cold created such a profound circulatory disturbance that susceptibility to cold injury was more pronounced. The practical realities of cold working conditions and specific behavioral practices underscore the interrelationship between activities, cold environments and injuries (15).

COLD INJURY PROFILE

Even though most cold injured are typically described as hypothermic or frostbite "victims", true accidental injuries are rare and certain behavioral predispositions appears to seriously increase probability of injury. Research on personality profiles of frostbite patients in Alaska 1980-86 provides some consistent evidence that certain populations are particularly vulnerable to cold injury (16). The Alaskan data found the majority of severe injuries were not merely consequences of work or sport but more often related to personality disorders, alcoholism, activity, and previous injury. Significant psychological correlates to amputation or tissue loss were: Undefined Activity (.91), Psychopathology (.60), and Alcoholism (.60). Significant physiological correlates to amputation with frostbite injury included: Severity - Deep or Superficial (.73), Previous Injury (.52) and Freeze/Thaw/Refreeze Experience (.48). Results showed 80 percent of patients engaging in Undefined Activities (neither work or sport) demonstrated the greatest tissue loss, whereas only 18 percent of the patients had sustained subsequent loss due to sport or work. This suggests serious injury is more often a product of irresponsible activity.

An extensive Swedish forensic study on hypothermia also found biopsychosocial factors to be related to fatal consequences. For instance, autopsies showed drug use frequency was 67 percent for males and 78 percent for females. This study further confirms the prevalence of drug correlates to cold injury or death (17). Perhaps lifestyle choices and biopsychosocial factors do represent the best known predictors responsible for severe cold injuries. At the very least, certain predisposing factors, decision making patterns, and behavioral actions seem to facilitate the probability of experiencing a potentially permanent and undesirable result. Table 1 shows the commonly recognized activities and classic risk factors contributing to cold injury (6).

Table 1. **Cold Injury Risk Factors**

Altered Mental Status	
Head injury	
Alcohol & other drug abuse	
Psychiatric disorders	
Military personnel exposed to cold, wet climates	
Outdoor sporting enthusiasts	
Skiing	Mountain Climbing
Running	Snow machining
Mushing	Hunting
Boating	Skating
The homeless, and the malnourished	
Elderly and newborns	
Laborers and industrial workers in the cold	
Oil, gas and pipeline workers	
Trucking, warehousing, fishing	

PSYCHOLOGICAL RESPONSES TO COLD

Psychophysiological research on predicting cold responses has shown constant prolonged cold exposure is capable of interfering with physical and psychological homeostasis. Specific pathophysiologic and metabolic consequences resulting from hypothermia have been well documented (18). For example, it is during the typical "shunting" or vasoconstrictive response that blood is directed away from extremities to vital organs in order to protect the thermal integrity of the body core. Hypothermic responses by their very nature also induce particular behavioral symptoms. Inadvertently however, these very behavioral responses increase susceptibility to frostbite and/or death. When a persistent and sufficient threshold of core temperature lowering is reached, a simultaneous and predictable sequence of psychological and behavioral responses produce the classic, insidious hypothermic pattern. The pattern follows a systematic and persistent heat loss to vital organs including the brain. A poorly regulated thermal metabolism results in progressive brain dysfunction and thereby decreases adequate or appropriate survival responses. Early detection remains critical since mental processes are essential to planning survival activities in field situations. The fundamental ability to maintain essential physical hydration requires minimum functioning mental capacity. Pain and discomfort of extremities are usual warning signals of heat loss, however numbing and shunting, distraction, and confusion can begin the cycle that disregards pending cold injury. Table 2 lists some of the cold related psychological and behavioral factors particular to hypothermia as a result of deteriorating consciousness (19).

Table 2.
Psychological and Behavioral Responses During Progressive Hypothermia

Apathy, Amnesia
Confusion, Sleepiness
Delusions
Difficult Motor Coordination
Disorientation, Irritability
Hallucinations
Impaired Judgment,
Irrational Thoughts
Lethargy, Fatigue, exhaustion
Paradoxical Undressing
Semicoma
Slowed Speech
Unconsciousness
Unresponsiveness

These behavioral effects are typical consequences of successive heat loss from body core and central nervous system. Normal survival capacity is seriously compromised and an individual's prompt corrective actions become virtually impossible. Cold performance activities require a steadfast, alert state of consciousness. This includes the vigilance that accompanies a mindful respect of the prevailing deadly possibilities. When careless attitudes and behaviors prevail, cold can become a great equalizer or punisher. Again, the careless disregard of the effects of drugs and alcohol rapidly diminishes the normal capacity for timely corrective responses.

Psychologically, cold is for many people an unpleasant four-letter word. Cold is commonly associated with complaints, avoidance, discomfort and occasionally pain. Generally, people prefer warmer climates because of greater physiological and psychological compatibility, less demand for special clothing, equipment and less threat of injury. Avoidance and fear of the cold for some individuals can reach phobic proportions. This may be accompanied by panic. A learned morbid fear of the cold occurring from past negative experiences or because of a conditioned response association is called "Psychrophobia". Although the occurrence of this psychological disorder is rare, it can result in a pronounced anticipatory fear reaction to the mere thought of cold exposure. Research has focused on the development and refinement of a cold fear test for identifying people who have developed a potentially maladaptive stress reaction to cold environments. This test can serve as a basis for selecting individuals with the highest positive cold environment compatibility (20). A pre-screening profile instrument seems appropriate and promising given the numbers of scientists, mountaineers, military, industry, and civilian populations who live, work and play in cold environments.

Other research on the mental and physical health of working populations in Arctic or subarctic cold environments have examined the increased susceptibility to sleep disturbance, headaches, depression, SAD (Seasonal Affective Disorder), cabin fever, Arctic hysteria, feelings of isolation and tendencies towards substance abuse. Specific psychiatric injuries in cold environments are unique and infrequent. The results indicate most workers display positive and healthy adjustment to cold and find comfort in extreme isolated conditions. Individuals who adapt well in such environments have sometimes been labeled "professional isolates" because they deliberately seek out remote working conditions consistent with their personal emotional needs (21). Adaptability to cold environments may be most agreeable to persons possessing a set of specific traits resembling the "Nordic personality" profile (22). Anthropological studies have found ecological, cultural, and socialization factors to be interactive correlates responsible for a personality style common to northern latitudes (23).

COLD INJURY IN SPORT

The numbers of participants in cold related sports are increasing annually and consequently so too the potential for greater cold related sport injuries. Alaska has many local and international winter sporting events where opportunities for joy are mixed with an inherent risk for painful cold harm. An injury can be an unanticipated consequence of unprepared, naive sports enthusiasts who pay a heavy price for their ignorance, possibly to the extent of a final surrender to a powerful force that does not play favorites. Many have met their fate or left Alaska with permanent reminders of how unforgiving and dangerous a cold environment can be. Alaska's geographic location offers remarkable cold recreational challenges while also allowing scientists excellent cold research opportunities. Out of growing concern for injury and death in Alaska's wilderness, many dedicated health professionals have maintained active research programs aimed at prevention and treatment of cold related injuries.

Since 1980, the University of Alaska, Anchorage has been the site of the Center for High Latitude Research under the direction of William Mills, M.D., surgeon and professor. Several faculty members from different departments: Psychology, Nursing, Health Science, and internationally recognized sport physicians have supported several field research projects regarding physical and psychological health, psychophysiology, injury prevention, and treatment protocols for cold weather sport performers. UAA research scientists have studied cold weather sport performers on the many popular cold races including: Iditarod, Iditaski, Iditabike, and Iditashoe (24-27) (see figure 2,3 &4). All these studies have examined the well debated differences between male and female cold weather performance. The data suggest that the sexes are different at different times on different races for different reasons and the debate continues. Overall, injuries have been few and minor. Risks are minimized by rules, regulations, check points, medical care and constant attention to tracking participants.

Other cold sport research projects in Alaska have focused attention on mountaineering because risk and potential injury are constant companions. Mt. McKinley, ("Denali" meaning the great one, the official Alaskan name) is North America's highest peak with an elevation of 6,194 m (20,320'). There are great numbers of climbers worldwide who successfully scale the icy, snow covered slopes at a 50 to 60 percent summit success rate. Over 1,000 climbers attempt the summit each year, 43 percent coming from foreign countries. Twenty-two rescue or recovery missions were conducted during the 1992 climbing season. The military and National Park Service spent over $430,000 for rescues during 1992. This past climbing year saw 105 cases of acute mountain sickness (AMS) and 38 cases of frostbite. There were 11 deaths in 1992 and 75 total recorded climbing deaths from 1932 to present. Thirty-three dead bodies remain on McKinley from this 60 year period. Sport medicine research camps on McKinley have studied hypothermia, frostbite, high-altitude pulmonary edema and acute mountain sickness associated with mountaineering. Two dedicated medical research base camps were established at 7,300 ft. and 14,300 ft. (28,29)(see figure 5). Other research conducted on McKinley climbers has sought to determine the psychological and physiological factors responsible for successful summit performance and injury prevention (13). The evidence suggests there is a significantly greater mortality rate for non-guided expeditions. Since the advent of guiding, only three out of the 44 climber deaths have occurred on professionally guided expeditions. Perhaps guided assents are safest because climbing guides are ever mindful of their liability to clients. They may choose safer routes and use more caution than non-guided teams. The most dramatic injuries, death and rescue missions have frequently included a disproportionate share of foreign born climbers. The Denali National Park Service is dedicated to education, communication and cooperative training with foreign climbing organizations to reduce the rising statistics. Injury ratios may reflect different understanding or appreciation of specific behaviors necessary to cold survival on McKinley. Lack of insight, training or experience on McKinely's unique cold, high altitude environment may directly account for this unbalanced frequency. Despite one of the worst storms on the mountain this past year, poor critical decisions and behavioral responses seem to help explain the most tragic consequences. Although weather conditions set the stage, how one responds may make all the difference.

The international sports community has recognized the increased activity in mountain sports and supports the ever increasing field of "mountain medicine." Because over a million accidents occur in mountains every year, professionals including mountain rescue teams, trauma specialists, clinicians, emergency physicians, physiologists, sport psychologists and cold researchers have contributed to the scientific literature on prevention and treatment protocols (30).

APPLIED PSYCHOPHYSIOLOGY FOR COLD INJURY

Applied psychophysiology represents a health care approach philosophy and procedure involving bio-behavioral methods in the self-regulation of physiology through learning techniques. Biofeedback training as a clinical procedure and training tool has been useful as an aid in learning to self-regulate peripheral skin temperature. Thermal biofeedback studies have examined skin temperature responses for the prevention, as well as treatment of cold injuries. Prevention studies have tested the effects of digital skin temperature training in cold environmental chambers while performing specific manual tasks (31). This award winning study reviewed the history of several indoor cold experiments and established current evidence for the effectiveness of biofeedback training for managing cold pain and increasing manual dexterity. Another Alaskan study examined the use of thermal biofeedback outdoors as an aid in temperature self-regulation for cold weather sports. Individuals were trained to consciously and voluntarily change surface skin temperature in the cold (32). Learning to improve thermal regulation in the cold was associated with less skin temperature decline and greater stability when compared to those without training or with only indoor training. All individuals when tested in the cold, regardless of training, overestimated their true temperature seven degrees higher regardless of training. Training to warm extremities appears to be a different discrimination task than learning to recognize and report actual skin temperature. The current research is also aimed at developing thermally sensitive gloves with thermistors linked to an auditory signal for early critical cold warning.

Aside from prevention, thermal biofeedback training has also been found useful in the clinical treatment of several vascular disorders. Many cardiovascular disorders including migraine, hypertension, diabetes, and Raynauds, have responded well to biobehavioral approaches (33,34)(see figure 6 & 7). Frostbite patients seem to be logical candidates for thermal biofeedback training specifically because the patient's vascular control may be irregular or dysfunctional. Biofeedback training methods require patients' active participation in the management of their disorder or injury through skill training. The use of computer technology to train patients to influence extremity blood flow has shown favorable results in the amelioration of the frequent vasospastic attacks common to cold injury, and also serves as a pain and/or anxiety management modality. Cold injuries of the extremities by nature are often accompanied by an array of vasospastic and vasoconstrictive responses depending on the severity of injury and methods used to thaw the frozen tissue.

Thermal biofeedback for frostbite injury was established in Alaska in the late 1970s and continues to be part of the Providence Hospital frostbite treatment protocol (35) (see figure 8). Physiological self-regulation via relaxation exercises and the specific feedback of thermal performance provides visual recognition of the power to influence physiology. Finger or toe temperatures are found to increase when patients are physically and emotionally relaxed. The temperature value can serve as an indirect indicator of vasodilatation. The average dorsal digital surface skin temperature at rest for most individuals is 90 degrees F., with males averaging 92 degrees F. and females 88 degrees F. However, this represents common resting temperatures while deep relaxation is found when skin temperatures reach 95 degrees F. or higher. Patients with frostbite, thermal disorders, or distressed individuals typically display extremity skin temperatures in the upper 60s or lower 70s. Vasoconstriction is regulated by the autonomic nervous system in the stress response and to neural activity during sympathetic arousal. Vasoconstriction and vasomotor tone are also mediated functions of the hormonal influence of adrenaline by the adrenal. Factors commonly found to increase vasoconstriction of blood vessels include: caffeine, nicotine, salt, sugar, stress, cold, and disease. Patients are instructed in ways to minimize further injury while participating in the behavioral management of their cardiovascular responses. This skill acquisition can be accomplished with or without medication or external heat application over successive training sessions. Many patients are able to reliably raise digital skin temperature +20 degrees F to the normal lower 90s following ten to fifteen half hour training sessions. A patient consciously assists in directing blood flow to injured areas either as an inpatient with bedside monitor or as an outpatient by using similar portable thermal instruments at home. Increased perfusion to distal areas and decreased pain usually accompanies large increases in hand temperature. Increase in blood flow to injured areas may mean the difference between dead and live tissue.

CASE STUDY EXAMPLE 1

A 20-year-old female patient reported having been cold exposed during substantial wind chill for several hours without gloves after locking her keys in the car. This probably resulted in superficial frostbite of her hands which were later allowed to warm indoors with forced warm air from a heater, and warm water. This patient presented with complaints of pain in both hands following most normal daily cold challenges. Hands appeared red (hyperemic), white (anemic) and blue (cyanotic), all within a few minutes of office observations. The episodic triphasic vasospams alternated between vasodilatation, venous stasis and vasoconstriction. She reported that vasospasm was most pronounced upon touching a cold steering wheel, cold car door handle, a cold glass or when emotionally distressed. Besides the typical patriotic red, white and blue symptoms, this patient experienced painful throbbing and burning attacks almost daily in winter or summer.

This rapid discoloration pattern is the classic sign of primary Raynaud's. However in this case, it is called "Raynaud's Phenomenon" or secondary Raynaud's since it is likely secondary to cold injury. There was no reported family history or obvious evidence of preexisting Raynaud's disease. This is important in differential diagnosis since the incidence of primary Raynaud's is five times greater in females than males. Regardless of the cause, the thermal biofeedback treatment goals are the same. Patient is taught voluntary self-regulation of surface skin temperature by placing a thermistor on the dorsal surface of the middle finger with hands resting on armchair away from body trunk heat. Training can include resting hands in lap to assist radiant heat conduction to experience warming. Soon afterward however, patient is instructed to make these thermal increases without assistance. The key to success appears to be the minute, consistent and immediate performance detail provided by the feedback monitor which enables the patient to make appropriate corrections or thermal adjustments.

This patient showed typical finger-to-hand demarcation line including both thumbs. Finger temperatures ranged from 69-72 degrees F. as measured with a portable infrared monitor. Infrared thermal assessments have been used for quick evaluation, thereby reducing thermistor placement artifacts or contamination by eliminating direct skin contact during measurement (34). Early training produced the normal 2-3 degrees F decrease or lack of significant change. The beginning sessions are often the poorest because patients have little skill in identifying or discriminating temperature values, or the ability to increase temperature at will. This skill requires a passive volition response that permits blood vessels to attain normal relaxed expansion. Following ten half hour sessions, this patient was able to increase skin temperature into mid 80s from the initial 70s at rest. Finally, following 16 sessions the patient was able to increase the temperature to above 90 degrees F. reliably in the clinic and home environment.

Home practice is an integral part of the thermal biofeedback training program so that patients can generalize their thermal response to normal cold challenges. Aside from the self-efficacy of influencing physiology by increased warmth in hands, this patient reported the added benefits of decrease in frequency of painful attacks. These painful episodes declined from 2-3 per day to one or two every two weeks or less. The patient's confidence comes from knowledge on how to increase temperature, as well as maintain less vulnerability to cold by slowing the rate of cooling.

CASE EXAMPLE 2

A 40-year-old male patient was admitted to Providence Hospital thermal unit with frostbite injury to both feet. Patient was a veteran who had had previous multiple hospital admissions and procedures because of phlebitis involving both feet. This patient had a history of alcoholism and frequently fell asleep outdoors. Patient also slept in poorly heated trailers or on unheated porches. On this occasion, he had been intoxicated and during a blackout he likely froze his feet which were later thawed at Brother Francis Shelter. He refroze both feet later the same day. Technetium 99^m studies demonstrated that, bilaterally, there was little perfusion beyond the metatarsal phalangeal joints of the feet. Despite all therapy including whirlpool, dibenzyline, Buerger exercises, biofeedback and diet, tissue demarcated at a level consistent with initial technetium scan. Following surgery, pathological specimens revealed gangrenous changes of fibroconnective tissue with marked extensive necrosis of toes, with abscess formation.

Patient required a psychiatric consultation and provided a difficult challenge to thermal unit staff because of frequent outbursts of anger, demand for narcotics and generally uncooperative behavior. Patient also had a history of drug dependency and evidence of a personality disorder. Management of this patient involved several special needs related to the treatment of preexisting disorders.

MEDICAL PSYCHOTHERAPY FOR COLD INJURY

Patients with traumatic thermal injuries whether they are burns, electrical, chemical or cold induced often experience considerable pain, anger, guilt, depression, and anxiety about the unknown future effects of their healing and recovery (37). Discussion of concerns, fears, and anxieties facing cold injured patients and their family systems are essential elements of good total health care management. Since the management of cold injuries frequently requires several weeks to several months in the intensive care unit, many collaborative efforts between the medical psychotherapist and health care team specialists facilitate high standards of patient care. Patients are often facing possible tissue loss, functional loss, questionable occupational future, alteration of body image, physical disability, permanent disfigurement, and several reconstructive surgeries. Total treatment process for these remarkable injuries involves health care teams appreciative of the many interrelated dynamics.

SUMMARY

Cold injured patients in Alaska come from many sources. Although sport and work continues to provide large numbers of cold injured, most severe repeat injuries tend to reflect other biopsychosocial consequences. Certain behaviors can increase the probability of injury, however all persons living in cold climates are potential candidates. One can decrease risk by education, knowledge and intelligent behavior. Proper respect for adequate protection and hydration seem to be critical factors. Understanding the psychological, physiological and psychophysiological aspects of the cold environment performer helps refine the prevention and treatment strategies for cold injury.

Skill training with bio-behavioral methods, such as thermal biofeedback, and the value of medical psychotherapy appear to offer continued promise by facilitating physiologic recovery from injury, as well as assisting in long term rehabilitation. Both approaches increase the likelihood of a favorable healing response by soliciting active patient participation. Medical Psychotherapy for traumatic injuries can also help identify and manage cognitive emotional issues for families and patients faced with the permanent consequences of severe thermal injuries. Thermal biofeedback therapy has the potential benefit of encouraging greater self-reliance and responsibility for self-regulating overall health by integrating self-management skills regarding physiology, diet and lifestyle. Inpatient and outpatient biofeedback training offers specific influence over vascular responses for healing, as well as providing an effective tool for pain management.

Interest in cold region habitation has continued to expand our study of human tolerance to harsh, extreme environments. Biological, psychological, sociological, and anthropological views on adaptation, habituation, acclimatization, and injury in cold environments acknowledges the role of development, learning and educated responses to cold environments (38,39). The study of health, performance, and injury prevention in extreme isolated cold environments has important strategic and scientific implications. What is learned from behavioral studies of cold survival provides an opportunity to increase our scientific knowledge and understanding. These cold research findings can assist in our future exploration of cold, underwater farming at great depths, and to far distance space travel to cold planets. The relatively new research frontier "Polar Psychology" has evolved to study how interactions with cold environments can have both positive and/or negative consequences. This research simulates the psychological factors likely to be encountered while exploring isolated cold regions of distant galaxies (40,41).

The psychological and psychophysiological correlates of cold experience appear to be a function of four interactive issues: the environment, genetic predisposition, learning or experience, and finally perception or cognition. Individual cold tolerance seems to relate heavily on sensation, perception and behavior. As Dr. Murray Hamlet, former director of cold-research division of the U.S. Army Institute of Environmental Medicine states, "cold depends on whether hell for you is a cold place or hot place." Some people, here in the North, claim that Alaska is "Heaven on Earth."

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Fig. 1. William Keatinge, M.D. and Jan Nyboer, M.D. measuring body core temperature via radio frequency telemetry during Ms. Lynne Cox's 1987 swim of the Bering Strait between USA and Russia at Little and Big Diomede, Alaska.

Fig. 2. Kevin Kings (UAA sportsmedicine student) and Ron Christensen M.D. (Iditarod medical supervisor) measuring dehydration of Iditarod Champion Susan Butcher with a Tetrapolar Bioelectric Impedance Analyzer (TBIA), following her first victory finish in 1986.

Fig. 3. Iditaski skiers starting the 1988 330k (210miles) journey.

Fig. 4 Iditabike racers anticipating start of the 1989 trek.

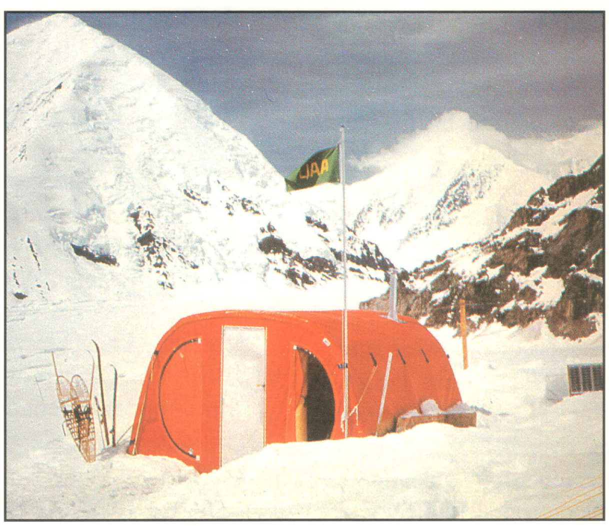

Fig. 5. The 1982 Denali Medical Research Project basecamp at 7,330 ft. on the Southeast Fork of Kahiltna Glacier, Mount McKinley.

Fig. 6. Thermal biofeedback training program with frostbite patients at Providence Hospital Thermal Unit during early 1980s.

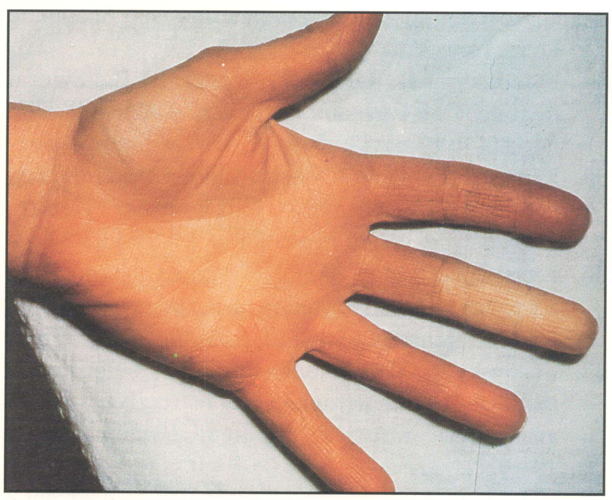

Fig. 7. Female patient with Primary Raynauds (laible vasomotor activity) with White Finger (pallor during vasospastic attack).

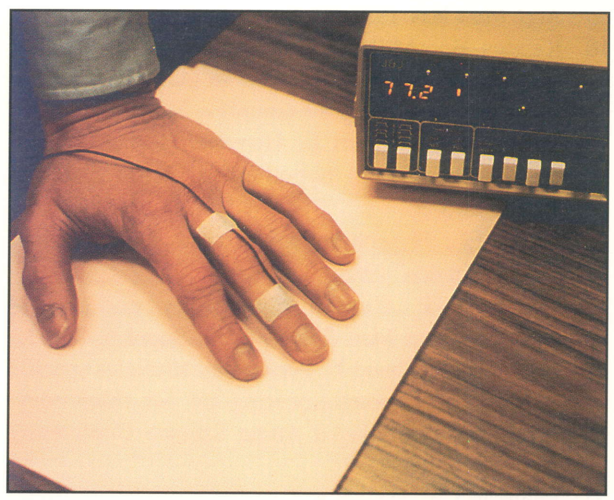

Fig 8. Thermal biofeedback response of a male Raynauds patients's surface skin temperature at 77.2 degrees F. (normal average is 92 degrees F. for males).

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