Medicine on the Mountain

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IN RECENT years our mountaineering journals have recorded the ascents of many previously unclimbed peaks and travels in many unexplored ranges. More and more mountaineering expeditions have taken to the field, and more knowledge has been gathered regarding mountaineering or expeditionary medicine.

Expeditionary medicine is an interesting form of practice which entails the evaluation of the physical and emotional state of the climbers, the organization of a table of supply and equipment, the prevention and treatment of injury and illness, and the study of environmental and occupational disease. This field of play is by choice in a remote area and is usually performed under difficult circumstances. In a group of expeditionary size the need for a physician as a medical officer is definite, especially in the remote areas of the Himalaya.

The problems encountered on such an adventure are many, and the responsibilities accepted are great. So far, there has been very little written on this subject and it is my object here to make certain suggestions that will aid in the planning of future expeditions. An expedition may experience a catastrophe or be medically uneventful, as exemplified by several groups in the Himalaya in 1954 and on Everest itself in 1953.

The planning by the medical officer for the health program and the decisions about the table of supplies and equipment for an expedition into the Himalaya or a similarly remote area depend upon the following factors, briefly listed:

1. *Objectives:* The considerations may vary depending on whether the expedition is a reconnaissance or an all-out assault on a major peak. In the latter case, the individuals participating may be exposed to a more severe and hazardous climbing environment and thereby to a greater chance of injury or illness.

2. *Logistics:* There are few mountain areas in the world as remote from sources of supply as the snow peaks of the Himalaya. The problems of portage, additional medical assistance, and supplies are matters that cannot

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be met easily, since the rough terrain and distances make the time factor a matter of weeks. Furthermore, an evacuation or air drop cannot be planned beyond the Indian-Nepalese border. The medical facilities that may sometimes be reached after a ten-day carry are not always adequate for definitive treatment; hence care must be provided over a long chain of evacuation.

3. *Size and duration of the expedition:* The amount of supplies carried will naturally vary with these two factors. The usual tendency, however, is to carry too much.

4. *Special problems:* These may consist of anticipated care of the natives encountered en route, responsibility of care for the expedition Sherpas and porters, if such are used, preparation of a definite plan for the treatment of cold injury, and special attention to adequate means of dealing with acute trauma. Also the problems of tropical disease as well as high-altitude living must be considered. As pneumonia has been so frequent a cause of death on recent expeditions, one needs a clear understanding of its possible etiology and prevention.

With these factors in mind and with the aim of preserving life and health, one may formulate a sound medical program and gather adequate medical supplies and equipment.

Medical Examinations

Prior to a strenuous mountaineering adventure complete physical and laboratory examinations are obviously necessary. The personnel usually appear to be in good health and have had much mountaineering experience. However, the rigors of long treks and living in both tropical and high-altitude environments will preclude a very careful evaluation on the expedition, and a problem which may have seemed minor can, in a mountain wilderness, become a major incapacitating condition. If a climbing party is by necessity small, its strength varies directly with the number who are physically fit. Unfortunately, one's ability to acclimatize cannot be predetermined other than by actual experience at high altitude, but the other factors relating to the physical and emotional state of the individual are of major importance in determining his actual climbing strength when conditions are extremely difficult and physical and emotional stress are great. As climbers frequently depend upon one another for preservation of life, it is vital that none should be handicapped. One handicapped climber in a party handicaps the team.

Medical histories and complete physical and laboratory examinations should be required. Certain conditions have been shown to become aggravated by high altitude and the stress of mountaineering expeditions. A

history of stomach-ulcer symptoms, a chronic cough or respiratory allergy, heart irregularities, and old injuries to the skeletal system should be thoroughly evaluated. These laboratory studies are suggested: complete blood count, urinalysis, Wasserman, blood typing, chest X ray and electrocardiogram.

Immunizations

To insure good health when traveling in foreign countries one should be immunized against the diseases which are prevalent in the area which he will visit. The requirements are set by the U.S. Public Health Service, the American Society of Tropical Medicine and Hygiene, and by the regulations of the Military Air Transport Service. The last requires a certified International Health Certificate before one is allowed to board a MATS plane. World-wide customs regulations, which can be obtained from the above sources, list the exact immunizations required for a specific country. For example, travel in India and Nepal requires immunization against smallpox, typhoid, para-typhoid, tetanus, typhus, cholera, yellow fever, and plague. The smallpox vaccination and the yellow fever inoculations must be certified by the Public Health Service or the Department of Defense. The agents for these immunizations can be obtained from most pharmaceutical houses except for the yellow fever immunization, which can only be obtained at a U.S. Public Health Hospital. A physician must administer and certify the immunizations and of course advise on those indicated.

Medical Supplies

The decision of what and how much medical equipment to include is a difficult one. To predict in advance precisely what will be needed is impossible. But one must try to prepare for any eventuality. The Medical Committee has prepared lists of supplies and equipment to suit various conditions and areas. The most useful items are the antibiotics; and penicillin in disposable cartridge form is exceedingly convenient. Items such as the tetracyclines or Erythrocin are useful and have minimal side effects on the gastrointestinal sytem. If a single antibiotic is chosen, Chloromycetin should be the most practical as it has an exceedingly broad spectrum against many organisms with records showing a low incidence of drug resistance. This is important as sensitivity tests cannot be performed in the mountains. It too has minimal side effects.

The analgesics, such as aspirin and Empirin with Codein, barbiturates, especially Nembutal and Seconal, the anti-malarial Chloroquine, a Vitamin B complex with supplemental Vitamin C, water purification and salt

tablets are also frequently used. A water purification tablet, an iodine compound, under the name of Globoline or Tetride, is more effective than the Halazone tablets. An amoebicide, plenty of material to suppress diarrheas and cough, adequate sunburn cream, a plasma expander such as Dextran, blood-transfusion equipment, and anti-snake venom are other items to be specifically considered depending upon the circumstances. Otherwise the medical supplies should include the stimulants, cardiovascular drugs, local anesthetics, dressings and usual other items that make up a field medical chest.

The outlay of surgical instruments should enable one to remove an appendix or repair a ruptured viscus, decompress an injured brain, install an adequate airway, and manage a fracture of a long bone as well as perform minor surgery of ordinary wounds. Examining instruments, a urethral catheter, a Levine stomach tube, and orthopedic plaster should also be included. Plastic surgical drages are a practical item, and ready Band-Aids are popular with the natives. The performance of the above procedures would of course depend upon the rapidity of the chain of evacuation.

Dental problems, such as repair of fillings, can be performed if a small amount of Zinc Oxide, Eugenol, and Phenol is available, and an extraction may be accomplished with a curved bone rongeur.

If oxygen equipment is to be taken for medical purposes only, a closed circuit apparatus of the Waters "To and Fro" absorber type is practicable. With soda lime, flow-meter pressure gauge and face mask and oxygen cylinders, this will make one good porter load.

Special permission is necessary to carry narcotic items across international borders.

Special Problems

To insure the health of a group traveling in remote areas consideration must be given to certain diseases and problems which are prevalent by nature of the environment. These are the following:

Malaria. Since World War II Chloroquine (Aralan) has proved to be a very efficient malarial suppressive as well as therapeutic agent. It is easily taken once a week as a suppressive agent, starting approximately two weeks before one enters a mosquito-infested area. Chloroquine is not malariacidal on the tissue phase of the parasite, and therefore Primaquine would be an advisable agent to be used in combination or following the Chloroquine. Insect repellents and mosquito netting are necessities.

Dysentaries. Tropical and native areas are commonly associated with diarrheas and diseases of filth, and one should strictly adhere to the practice of *not* eating native food and beverages or uncooked vegetables and dairy products. In essence, military sanitation methods must be practiced. Drinking water must be treated by boiling or by the use of water purification tablets.

Insects and Leeches. Effort should be made to avoid close contact with native dwellings and areas of filth. Food should be protected from flies, and preparation carried on well away from designated latrines. Perhaps leeches are a necessary evil to reduce the high red blood-count of acclimatized man, and their bite is painless, but secondary infections may develop. Repellents are moderately effective when incorporated in water-resistant silicone creams. Tight-fitting clothing around wrists, ankles, and neck is the best barrier.

Vitamin deficiencies. As diets on mountaineering expeditions are not always well balanced, supplemental vitamin therapy is advisable on the longer excursions (over three weeks). The items containing specifically high concentrations of Vitamin B and Vitamin C are most beneficial.

Heat Exhaustion. On both approach and return journeys considerable hot, dry marching may be encountered. Watering places may sometimes be far between, and it is imperative that when traveling in such areas, all carry canteens and use salt tablets for replacement purposes. Occasionally intolerance to salt tablets occurs, and a more suitable method of salt replacement is to dissolve two 10-grain salt tablets in a canteen of water, thus obtaining a concentration of 0.1% to 0.2%, which is usually well tolerated. Under such conditions as much as 12 grams of salt may be needed. The usual daily requirement is 4 to 6 grams. Adding generous amounts of salt to one's food may be sufficient.

Frostbite. The problem of frostbite is one that is not completely understood as there are many conflicting reports in the literature. The injury consists of tissue necrosis produced by severe cold after a sufficient period of exposure. The resulting cellular tissue damage and gangrene is either due to the cold itself or to the physiological response of blood vessel constriction. The latter cause seems less likely. The general condition of the individual as well as his protection at the time of exposure also determine the degree of tissue damage. As the circulating blood is the primary heating system in the body, any decrease in this volume which might occur at high altitude, where severe dehydration exists, would accentuate the process. It is sometimes difficult to tell how much tissue is

affected. Dead tissue may merely appear slightly discolored and have a feeling of warmth imparted to it from the adjacent normal tissue. This is misleading, as one is sometimes overly optimistic about the damage only to observe later that the gangrene has extended.

Of course, the best treatment is prevention with adequate clothing, gloves, boots, oxygenation, food, and fluid intake, and minimizing of fatigue and perspiration. Military experiences in the Korean War and research have resulted in the modern concept of rapid thawing of frozen tissue and abstinence from incurring further tissue injury by brisk rubbing or prolonging the thawing process. Large damaging crystals are prevented from forming in the tissues by rapid thawing, and a marked vasodilatation in the extremity is demonstrated proximal to the injury. This method is carried out by immersing the affected area in a water bath of 55 degrees centigrade, or 130 degrees Fahrenheit. This procedure can usually be performed without difficulty at a high camp with the available equipment of cooking pots and Primus stoves. It should be done promptly.

The treatment may be painful, but pain can be controlled with narcotics. Following this, sterile moderate-compression dressings should be applied to control the edema before it develops. Some authorities advise no dressings. However, some form of sterile protection should be afforded while the patient is being transported. Antibiotics are begun immediately, and the patient should not be allowed to walk if a foot is involved. It has also been suggested that Vitamin C and Rutin be given in 500 mgm. doses. The use of Rutin has been suggested as a prophylactic agent when given in these large doses over the period of exposure, but this is experimental.

Additional methods of treatment, such as dilatation of blood vessels by oral medication or nerve (sympathetic ganglion) blocks and the use of anticoagulants, have not proved especially valuable. The gangrenous area will become fully demarcated after about a month, and no attempt at amputation should be performed earlier.

Individuals vary in their tolerance to cold, and the effect of cold is definitely accentuated at high altitude. A cold-susceptible person, especially one who has had a previous cold injury, would be least able to tolerate cold under these conditions, as would individuals with arteriosclerosis or other vasoconstrictive diseases. Smoking may also have an aggravating effect.

Snow Blindness. The condition results from prolonged exposure of the eyes to the glare of sun- and sky-light and reflected light from snow,

water, and rock. Light rich in ultraviolet creates a burn primarily on the corneal epithelium. The other structures of the eye are involved little. The amount of light necessary to produce symptoms varies with individuals; there may be enough even on a cloudy day. There is usually a latent period of six to eight hours before the symptoms develop. Pain may gradually become intense and incapacitate the individual completely. The dry, gritty, smarting, and tired sensation of the eyes may progress to excessive lacrimation and sensitivity to light. Fortunately, healing occurs rapidly, but may require two or three days in a severe burn. So far, treatment has been limited to the use of a local anesthetic, cold packs to the eyes, and medication for pain. There are no reports as yet in the literature on the use of Hydrocortone for this condition. As this steroid hormone inhibits inflammatory processes and fibrous tissue proliferation, it is a logical choice in such a condition where the main pathological reaction is inflammation of the cornea from a photochemical burn. The result with Hydrocortone Acetate Ophthalmic Ointment when applied early in the course of snow blindness is excellent. Only one or two applications are necessary, and the symptoms are dramatically relieved in eight to ten hours. Though snow blindness is not seen frequently, when it does occur it can be totally disabling, and this method of treatment is excellent. Of course, adequate eye protection from the glare is of utmost importance.

Respiratory Problems. Past experience has demonstrated the marked frequency of respiratory problems, particularly on Himalayan expeditions. The frequency of pneumonia in climbers at these high altitudes has been noted especially. A review of medical histories, as they change from stage to stage on expeditions, reveals how important a part the epidemiological and environmental factors play in the pathogenesis. Himalayan experience is not unique, but it serves as a good example.

A particular characteristic of porters and Sherpas and in fact, of all Nepalese, is their continual coughing and nasal congestion. If you expose men from an entirely different environment to such a group and allow them to live in the unavoidable close contact that exists on this type of an expedition, then what would be expected will happen. Within the first two weeks all will develop upper respiratory infections consisting of minor degrees of inflammation of the nose and throat, sinusitis, and bronchitis. It is obvious that these infections are contracted from local inhabitants, and unless complete isolation techniques are practiced, which is usually impractical, these infections will be spread. This initial "cold" may clear within ten days, and by the time of arrival at a base camp a certain amount of immunity for the remainder of the stay will have developed. If individual

eating and drinking utensils are used the situation may be better controlled. However, most attempts at segregation break down sooner or later and most certainly do so at high camps.

Therefore, individual resistance is important and should be built up over a period of at least a month before any serious climbing on the mountain is performed. During this time initial infections will be overcome while conditioning and acclimatization is progressing at lower altitudes.

Above 16,000 feet the acclimatization process is complicated by other respiratory tract difficulties. The most common is the hacking, sometimes propulsive, minimally productive coughs. Each climber experiences this on gaining higher altitudes, some more than others. There seems no doubt that the explanation for this coughing results from the mechanical factors prevalent in the evironment. The dry cold atmosphere, the relative anoxia, the rapid breathing and dehydration are all causes for irritation of the membranes of the respiratory tract. The windblown dust from a glacier moraine is also a source of irritation. Of these factors the state of hydration seems a very prominent feature. The amount of coughing was noted on one occasion to be the greatest in those individuals who were the least well hydrated and demonstrated the highest urine specific gravities. This brings out again the importance of adequate fluid intake at high altitude.

It was interesting to note that much of the coughing was paroxysmal and propulsive in nature and worse at night, and that a certain amount of voluntary control could be exercised. However, the cough mechanism has been called the "watch dog of the lung," and is essentially an involuntary reflex action to keep the respiratory passage free of obstruction. This violent coughing, whether or not it has organic basis, is certainly traumatic to the throat and lungs in itself.

In ordinary life causes for a cough are many. A foreign body, the inhalation of an irritating substance, an inflammatory process of the respiratory tract, a tumor, allergic disease, cardiovascular disease, tuberculosis, and other pulmonary and extra-pulmonary causes are but a few such disorders.

What happens in the course of events as individuals exist at high altitudes leads one to a clear explanation of the frequency of pneumonia, which has been seen so often. In most of these cases of pneumonia the onset has been relatively rapid, as has the progression of the disease. The environmental factors previously mentioned lead to a retention of bronchial secretions by reduction of the bronchial caliber, by a defective expulsive mechanism, and by changes in the amount and character of the secretions themselves. The bronchial caliber is reduced by congestion and bronchospasm created by the dry atmosphere, dust infection, and bron-

chitis. Bronchial secretions are undoubtedly increased by these factors, but of more importance is the increase in viscosity resulting from dehydration. The maintenance of an adequate fluid intake is very difficult at high altitude, and the insensible loss through the respiratory tract is great. This amounts to approximately one quart of water a day in the normal individual at sea level and must be much above this at high altitude. A minimum of six to eight pints of fluids a day is required. Bronchial secretions are largely of water and contain 6% of solids, of which 3% is mucin. Any increase in the proportion of mucin creates a viscid sputum, which is difficult to cough up and can easily lead to obstruction of the smaller bronchi.

The expulsive mechanism becomes defective because of depressed ciliary action and an impaired cough. Ciliary action in the large bronchi ordinarily propels secretions proximally, but with anoxia, increased viscosity, and congestion, this action becomes ineffective. Further, the action of coughing may be impaired by a chest injury or a pleurisy.

All of these factors lead to a retention of sputum and the great possibility of obstruction within the lung creating a partial or complete collapse (atelectasis) of the lung. This can occur suddenly and be in itself fatal. It will offer an ideal culture medium for organisms harbored by the individual or contracted from others and result in a true bronchopneumonia. Any respiratory embarrassment in severely stressed and fatigued individuals at high altitude is very critical and progresses to fatal termination rapidly.

This experience leads to a plan of management which it is felt will minimize the occurrence of serious complications or loss of time. As has already been indicated, at least a month should be allowed for men to overcome initial infections and condition themselves at lower altitudes. The use of individual utensils and segregation should be practiced as much as practicable. The antibiotics, though having no effect on the initial cold, certainly will control the complicating bacterial developments or secondary infections. The annoying coughs incurred at higher altitudes can be eliminated to a certain extent by adequate hydration, which is most important, and by cough mixtures. Probably sodium or potassium iodide would be the most effective expectorant. A cough suppressant is necessary, especially at night, to allow adequate sleep. The acclimatization above 16,000 feet should progress slowly, and the climbers should remain definite periods of time between successive elevations. It has been noted that as acclimatization improves the degree of respiratory irritation decreases. The development of any untoward symptom should demand the immediate evacuation to lower elevations. Again antibiotics must be available for immediate initiation of

treatment. The oral antibiotics are particularly useful. Oxygen should be available at least for a medical emergency as described earlier. If circumstances permit, oxygen used in climbing would undoubtedly eliminate many respiratory problems. Cigarette smoking does not seem to make any appreciable difference. However, it would be logical to expect that nonsmokers would have less irritation to the mucous membranes of their respiratory tracts.

Acclimatization

Most individuals on climbing to altitudes above 10,000 feet will notice certain symptoms of altitude intolerance. These are shortness of breath, fatigue, loss of appetite, lassitude, headaches, nausea, insomnia, irritative coughs, impatience, depression, and nocturnal muscle-cramps. These symptoms will gradually subside and disappear as the individual becomes more acclimatized. It has been shown that the process of acclimatization to altitudes above 18,000 or 20,000 feet requires between four to six weeks. Definite changes can be demonstrated in the circulatory, respiratory, and endocrine systems.

Certain medications can be very beneficial for existence at the higher altitudes. As proper sleep is a very important requirement, the use of barbiturates such as Secondal and Nembutal in normal dosages will provide the necessary comfort and relaxation. When they are used in this fashion no untoward effects should be experienced. If at all possible and practicable, the individual should return to a lower altitude for sleeping.

States of lassitude and depression have been noted following prolonged living at high altitudes. Certain medications are beneficial in treating these conditions and exert a dramatic effect in lifting the mood and producing a desire for activity. A medication such as Desoxyn, 5 mgm., and Nembutal, 45 mgm., used in combination under the trade name of Desutal prepared by Abbott Laboratories, has been shown to be very effective. Similar products should also have the same effect.

Again it is important to stress that adequate fluid intake above all enables an individual to perform more effectively at high altitude, as does a good diet. Adding extra salt stimulates thirst and increases fluid intake. It has been shown experimentally that in the unacclimatized individual the sodium in the body is depleted through excretion. Sodium chloride is utilized to restore this balance. Sometimes a strong will power has to be exercised to cope with sticky cereal and rice-tuna dishes. Forcing liquids may mean getting out in the night, but there are solutions.

Conclusion

These ideas indicate that a definite medical program is an important part of any major expedition. Sound medical consultation also is advisable on smaller trips in which a physician is not participating. Thus may serious problems be prevented, hazards be minimized, and unnecessary rescue efforts eliminated. There will still be plenty of opportunity for adventure!