High Altitude Pilgrimage Medicine

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Abstract

Religious pilgrims have been going to high altitude pilgrimages long before trekkers and climbers sojourned in high altitude regions, but the medical literature about high altitude pilgrimage is sparse. Gosainkunda Lake (4300 m) near Kathmandu, Nepal, and Shri Amarnath Yatra (3800 m) in Sri Nagar, Kashmir, India, are the two sites in the Himalayas from where the majority of published reports of high altitude pilgrimage have originated. Almost all travels to high altitude pilgrimages are characterized by very rapid ascents by large congregations, leading to high rates of acute mountain sickness (AMS). In addition, epidemiological studies of pilgrims from Gosainkunda Lake show that some of the important risk factors for AMS in pilgrims are female sex and older age group. Studies based on the Shri Amarnath Yatra pilgrims show that coronary artery disease, complications of diabetes, and peptic ulcer disease are some of the common, important reasons for admission to hospital during the trip. In this review, the studies that have reported these and other relevant findings will be discussed and appropriate suggestions made to improve pilgrims' safety at high altitude.

Key Words: altitude illness; medical problems; pilgrims; religion; South Asia

Introduction

PILGRIMS HAVE BEEN TRAVELLING to high altitude pilgrimage sites since time immemorial (Basnyat, 2006), and they outnumber trekkers and climbers to the Himalayas because annually there are millions of pilgrims in these high altitude pilgrimages (Table 1) compared to trekkers and climbers to high altitude areas who number only in the thousands. Altitude illness (Bartsch and Swenson, 2013), which comprises the relatively benign acute mountain sickness (AMS) and life-threatening high-altitude cerebral edema (HACE) and high-altitude pulmonary edema (HAPE) have been well documented in many pilgrims (Basnyat et al., 2000; Koul et al., 2013; MacInnis et al., 2013a). In addition, pilgrims also suffer from traumatic injuries on the trail and common pre-existing problems such as diabetes, peptic ulcer disease,

and coronary artery disease, which may be exacerbated with poor drug compliance during travel, dietary changes, or the added stress of exertion and hypoxia at high altitude (Mir et al., 2008; Yatoo et al., 2012).

Most of the studies (as discussed below) of altitude sickness and other medical problems in pilgrims are from the Gosainkunda Lake (4300 m) near Kathmandu (1300 m), Nepal, and the Shri Amarnath Yatra (3900 m) in Srinagar (1600 m), India.

This review begins with a brief overview of these pilgrimages. Then, published studies regarding altitude illness in pilgrims from Gosainkunda will be examined, followed by other medical problems recorded amongst the Shri Amarnath pilgrims (Fig. 1). The last section is devoted to recommendations to try to ameliorate the present plight of the pilgrim at high altitude.

TABLE 1. SOME HIMALAYAN PILGRIMAGES

<i>Pilgrimage</i>	<i>Route\Method of Ascent</i>	<i>Estimated number of pilgrims per year</i>	<i>Time to reach pilgrimage site</i>	<i>Season\Time for pilgrimage</i>
Kailash Manasarovar in Tibet. A sacred mountain (Kailash, 6700 m) with a nearby lake (Manasarovar, 4500 m) Hindu, Buddhist, and Jain worshippers.	Via India, Nepal or Lhasa, Tibet. By foot (India), motor vehicle (Lhasa or Kathmandu), or by helicopter from Simikot to Hilsa in western Nepal, followed by motor vehicle journey.	40,000	4 days or more, depending on the route	May to Sept.
Shri Amarnath Yatra (3800 m) in Srinagar, India. The Shiva temple is inside a cave. Hindu worshippers	Pahalgam route (longer) or the Baltal route (shorter). Foot, horseback, or helicopter	400,000 to 600,000	1 to 5 days depending on the route.	End of June to first week of August.
Gosainkunda (4300 m) in Rasuwa district, Nepal. Main ritual is taking a holy bath in the kunda (lake). Hindu, Buddhist worshippers	Kathmandu to Dunche (2000 m) by motor vehicle and then by foot.	10,000 to 20,000	1 to 2 days from Dunche	One week in August around Janai Purnima, the sacred-thread festival.
Badrinath (3100 m) in Uttarakhand, India. Hindu worshippers (Vishnu temple)	By motor vehicle from New Delhi, India	1,000,000	1 or 2 days from New Delhi.	May to October.
Kedarnath (3500 m) in Uttarakhand, India Hindu worshippers (Shiva temple)	By motor vehicle from New Delhi, India. The final ascent is by foot, on horseback, or palanquin.	600,000	1 or 2 days from New Delhi	May to October
Muktinath (3700 m) in Mustang district, Nepal. Hindu and Buddhist worshippers (Vishnu temple).	By motor vehicle from Kathmandu, Nepal or plane to Jomsom (2800 m) and then via motor vehicle or by foot.	30,000	2 to 3 days	March to May or Oct and Nov
Hemkund Sahib (4600 m) in Uttarakhand, India. Predominantly Sikh worshippers.	By vehicle to Govindaghat (1800 m) and then by foot.	150,000	1 to 2 days	June to October

Overview on pilgrimages

High altitude pilgrimages in the Himalayas appear to be a rich source of spiritual fulfillment and a path to salvation. Many feel that experiencing hardship during the trip is

FIG. 1. The Shri Amarnath Yatra congregation.

nothing to shy away from; indeed, suffering may be perceived as an integral part of the trip. Some pilgrimages take place in the Vedic calendar month of Shrawan (July\August), which is the month dedicated to Lord Shiva (Mahadev) who resides in the mountains and is one of the main deities worshipped in these pilgrimages. Pilgrims chant prayers and atone for their sins by taking “holy dips” in the sacred high altitude rivers and lakes (“kund”). Although a representative sample of pilgrimages are included in Table 1, many lesser known pilgrimages [for example, Damodar Kund (4800 m), Dudh Kund (4500 m), and Lake Tilicho (4900 m)], all located in the Nepal Himalayas, are not listed.

Pilgrims try to visit as many pilgrimages as possible in their lifetime to gain religious points and are less likely to repeat the same pilgrimage. Some may use a trekking or travel agency, but in general the accommodation and food on these trips is usually spartan. Due to overcrowding, hygienic conditions are poor (e.g., in Gosainkunda). The more popular pilgrimage sites may have hotels and tea houses with adequate food and mineral water supplies, but the remote pilgrimages may require portering in food, tents, and sleeping bags for the group. In general, most pilgrims do not have proper footwear or adequate warm clothes.

Epidemiological Studies of Pilgrims at Gosainkunda Lake

The first study reported from the Gosainkunda Lake area was carried out in 1991 (Basnyat, 1993), followed by another in 1998 (Basnyat et al., 2000). Both clearly showed how rapidly large numbers of pilgrims ascended to the sacred site, for example, ascending to 4300 m from 2000 m in 2 days. Both of these were cross sectional studies. The 1993 study revealed a relatively low incidence of AMS (4%), and this may have been because only pilgrims who were visibly ill were counted compared to the 1998 study that was based on randomized sampling and revealed that 68% suffered from AMS, with women five times more likely to suffer from AMS. A study of AMS in children (families sometimes travel together during pilgrimages) at Gosainkunda Lake showed a rate of 47% (Pradhan et al., 2009).

A recent large prospective study (MacInnis et al., 2013a) followed a cohort of 538 pilgrims from about 2000 m to Gosainkunda Lake in 2 to 3 days. AMS in this group was 34%, and women in this study were also more likely to suffer from AMS than men. The lower incidence of AMS in the recent study (compared to the 1998 study) may have been due to the design (cross sectional vs. longitudinal), but it also may reflect the relentless drive by the Himalaya Rescue Association (HRA) and the Mountain Medicine Society of Nepal (MMSN) to increase awareness of this problem in pilgrims, although the rate of ascent remained the same (i.e., 2 to 3 days).

In general, besides the two large pilgrim studies (Basnyat et al., 2000; MacInnis et al., 2013a) which show that women pilgrims suffer more from AMS, a large prospective study (Richalet et al., 2012) and smaller studies (Kayser, 1991; Honigman et al., 1993) of non-pilgrims are also in agreement with this finding, but many other studies (Hackett et al., 1976; Maggiorini et al., 1990; Schneider et al., 2002; Gaillard et al., 2004; Mairer et al., 2010) do not show sex to be a risk factor for AMS. Why do women pilgrims seem to have more AMS? One reason may be that women are more likely to admit AMS than males.

Importantly, fasting on religious pilgrimages is not unusual (Sahota and Panwar, 2013) especially amongst females, and they may have avoided water in addition to food, thus making them more dehydrated and possibly hypoglycemic as well. Both dehydration and hypoglycemia symptoms may mimic AMS (Litch, 1996; Hackett and Roach, 2001). Dehydration may also predispose to AMS, possibly by bicarbonate retention, alkalosis, and respiratory inhibition, as has been suggested by some smaller studies of pilgrims at high altitude (Cumbo et al., 2002; Shah, Braude et al., 2006). One pilgrim study revealed that higher venous bicarbonate concentration was associated with hypoxemia, but not acute mountain sickness after ascent to 4250 m (Cumbo et al., 2005). In addition, other non-pilgrim field studies also have suggested a relationship between AMS and dehydration (Basnyat et al., 1999; Richardson et al., 2009a; Mairer et al., 2010), although Castellani and colleagues (2010) reported no significant effects of hypohydration on AMS, and hyperhydration may actually have negative effects (Richardson et al., 2009b).

In a large prospective study (MacInnis et al., 2013a), severity and incidence of AMS increased with age contrary to many studies (Honigman et al., 1993; Gaillard et al., 2004; Richalet et al., 2012). The first pilgrim study in Gosainkunda Lake also revealed that AMS was more severe in the older age group (>40 vs. <40). In fact, these are the only two studies in the medical literature showing that the older age

group may be more susceptible to AMS. The Western trekking and mountaineering groups may be a self-selected population with AMS-susceptible individuals less likely to continue this sport, unlike older and perhaps physically unfit pilgrims undertaking pilgrimage for religious reasons.

In addition, older pilgrims may have been more dehydrated than younger pilgrims by avoiding food and water on ascent. Although co-morbidities were not taken into account in the Gosainkunda Lake studies, the studies from Srinagar (Singh et al., 2005; Ganie et al., 2012; Yatoo et al., 2012; Koul et al., 2013) reveal that pilgrims admitted to hospital have important co-morbidities such as pulmonary diseases that may increase their risk for AMS. Importantly, because many of the elderly may not be in good physical conditioning but feel obliged to do the pilgrimage, they may well be physically very exhausted, which also mimics AMS. Although there are American data (Roach et al., 1995) to show that elderly people with preexisting cardiovascular or pulmonary disease can safely visit altitudes of about 2500 m, the pilgrims here rapidly ascended to higher altitudes by foot, at times with uncontrolled pre-existing disease.

There is evidence to show that infection (specifically respiratory or gastrointestinal infections) in the trekking population at high altitude in the Everest region may predispose to AMS (Murdoch, 1995; Basnyat et al., 1999). Pilgrims too at high altitude with respiratory infections are more prone to AMS (Cumbo et al., 2002). Because overcrowding is a regular feature of many high altitude pilgrimages (Basnyat, 2002; Singh et al., 2005), infections may play an even more important role in acquiring AMS in the pilgrims population than in the other groups.

All the pilgrim studies from Gosainkunda that have examined ascent rates have clearly shown that a faster rate of ascent leads to AMS (Basnyat, 1993; Basnyat et al., 2000; MacInnis et al., 2013a) because fast ascents do not allow for proper acclimatization. This relationship between ascent rate and AMS is well known (Hackett et al. 1976; Schneider et al., 2002). In the popular Everest trek, for every night spent between 3000 m and 4300 m, the risk of AMS decreases by 19% (Basnyat et al., 1999).

Although the 2000 study from Gosainkunda Lake (Basnyat et al., 2000) documented very high rates of HACE (31%) and HAPE (5%), other studies, including the recent 2013 prospective study (MacInnes et al., 2013a), did not report on HACE or HAPE rates although anecdotally HAPE and HACE continue to be seen in the pilgrim populations at Gosainkunda Lake. HAPE and HACE have been well documented in the Shri Amamath Yatra in Srinagar (Koul et al., 2013), and there is also a recent case report of HAPE in a pilgrim from Kailash Manasarovar (Panthi and Basnyat, 2013).

Other studies from the Gosainkunda Lake include genetic studies that revealed no association between variants in the ACE and angiotensin II receptor 1 genes (some studies have shown that ACE gene polymorphism predicts performance in elite mountaineers) and AMS in Nepalese pilgrims (Koehle et al., 2006). In the recent prospective study (MacInnis et al., 2013a), forty-eight pairs of siblings were identified, but family history was not found to be a risk factor for AMS although signs of familial aggregation were evident. The pilgrims have also helped out with trying to refine the Lake Louise Score Questionnaire and AMS diagnosis (Macinnis et al., 2012; 2013b). Finally, oxygen saturation and diastolic blood pressure in 41 pilgrims were negatively and positively correlated with Lake Louise Score, respectively. Receiver

operating characteristic analysis indicated that an oxygen saturation of 86% or greater was associated with a very low likelihood of AMS at the Gosainkunda Lake. No heart rate variability parameters were different in the AMS group as compared with the control group (Koehle et al., 2010).

Medical Problems in Shri Amarnath Yatra Pilgrimage (3800 m)

For 6 weeks in July and August every year, 300,000 to 600,000 pilgrims do the Shri Amarnath Yatra pilgrimage in Srinagar in India (Koul et al., 2013). There are no prospective studies of pilgrims as in Gosainkunda, but there are publications of medical problems in pilgrims admitted to hospitals in Srinagar, the largest city near the pilgrimage site which is also the state capital.

Of the thirteen pilgrims who were brought down from high altitude with diabetes mellitus (DM) (Ganie et al., 2012) during the 2006 and 2007 pilgrimages to Shri Amarnath, eleven had fulminant diabetic ketoacidosis, and there was one pilgrim each with hyperosmolar hyperglycemia and hypoglycemia. The diagnosis was based on history, physical exam, and blood tests including blood gas. Six out of thirteen patients were on insulin, and some had stopped taking insulin on the trip. Three of the patients did not know they were diabetic. Five patients had documented infections: two with urinary tract infection, two with respiratory tract infection, and one with acute gastroenteritis. Four out of thirteen patients starved themselves as part of their religious rite for more than one day. Importantly, all patients complained of extreme fatigue. Amongst these patients there was also an important lack of knowledge about their disease. One patient died, but the others were treated successfully. The incidence of diabetes in pilgrims is not possible to find out without baseline data, but clearly with the demographic transition in South Asia the numbers may be high. South Asia has the highest number of diabetics in the world, and now both cardiovascular and infectious diseases are common in this region (Basnyat and Rajapaksa, 2004).

In another study in 2006, the government health services in Kashmir extended medical aid to about 40,000 pilgrims. Of these, 172 were admitted for nontraumatic surgical disorders (Mir et al., 2008). The commonest cause for admission was exacerbation of acid peptic diseases. Nine emergency surgical procedures were conducted, the commonest cause of intervention being perforation of duodenal ulcer. This finding is not surprising as acid peptic ulcer disease is one of the most common problems encountered in South Asian medical outpatient clinics. What role high altitude played in the exacerbation of the disease in these pilgrims is not possible to define, but it is well known that people with peptic ulcer disease should exercise caution when travelling to high altitude (Wu et al., 2007).

Finally, from July 2011 to Aug 2011 during the Shri Amarnath Yatra period (45 days), 185 pilgrims were admitted to a hospital in Srinagar (Yatoo et al., 2012). One hundred were promptly discharged with arrangements for follow up, but 85 patients with a median age 53 were admitted. Acute myocardial infarction, polytrauma, head injury, HAPE, gastroenteritis, diabetes, COPD, and stroke were the diagnosis in these pilgrims in decreasing order. Six people died, out of which 4 were >65 years. Most of the people who die succumb in the field (before being brought to the hospital); for example, the conservative death toll in 2011 and 2012 among 600,000 pilgrims was 239 recorded deaths amongst the pilgrims who had visited the Shri Amarnath shrine (Koul et al., 2013).

What Can Be Done?

Improved awareness of altitude illness and other problems in pilgrims

Increased awareness of altitude sickness amongst the pilgrims will be very helpful as many people, including trekkers in the Himalayas, are not aware about the basics of altitude sickness (Glazer et al., 2005; Paz et al., 2007). Especially for the rapid ascents, if proper acclimatization is not an option [for example, going from Kathmandu, 1300 m to Lhasa, Tibet 3650 m (Basnyat, 1998)], acetazolamide prophylaxis for those without sulfa allergy (125 mg bid a day before and continuing for 3 or 4 days into the trip) may be useful (Bartsch and Swenson, 2013; Zafren, 2014). Acetazolamide is a tried and tested drug in the prevention and treatment of AMS (Hackett and Roach, 2001). Many local remedies (Zafren, 2014) are available but may not work, for example, garlic (which is locally thought to be very helpful for preventing AMS) was found ineffective (in fact, garlic increased AMS risk) in pilgrims (MacInnis et al., 2013a). Since AMS appears to be more common in older pilgrims (>35 years), more attention needs to be focused on them for the prevention

TABLE 2. WHAT CAN BE DONE

Improved awareness of altitude illness and other problems in pilgrims

If proper acclimatization is not an option, advise using acetazolamide (in those with no serious sulfa allergy), 125 mg bid, starting a day before the trip and continuing for about 3 days into the trip.

To make the trip less strenuous, advise simple aerobic fitness program starting some months prior to the trip.

Pre-acclimatization: advise spending one week between 2000 to 3000 m as close to the time of pilgrimage as possible.

Recommend avoiding dehydration by drinking 2 to 3 L of fluid per day and proper foot wear for slippery trails and warm clothes to avoid hypothermia.

Pre-travel evaluation

Pre-existing medical problems such as diabetes, coronary artery disease, and peptic ulcer disease need proper evaluation and optimal medical treatment before the trip. Clear legible list of diagnosis and drugs being used need to be carried in person.

A hand-held pulse-oximeter may be useful especially in those with cardiorespiratory problems.

Infection control

Encourage usage of hand sanitizer.

Appropriate immunization (for example, influenza vaccine) and travel-related vaccine should be emphasized especially to the VFR (visiting friends and relatives) group of tourists.

Insect repellents and malaria prophylaxis may need to be considered.

Improved awareness of altitude illness in local health care professionals

The local doctors in the health camps on the pilgrimage trails need to stock acetazolamide, nifedipine, and dexamethasone and know the clear indications for their usage.

The health camps should have a hyperbaric bag (for example, the Gammow Bag) which may be life-saving, especially in these austere settings.

of altitude sickness. Because many of these pilgrims may be physically unfit and not have sufficient reserve to cope with the expected loss of exercise capacity at high altitudes of about 1% for every 100 m above 1500 m, a simple fitness program some months prior to the trip to avoid exhaustion during the trip, and pre-acclimatization (spending about 1 week between 2000 to 3000 m as close to the time of pilgrimage as possible) may be very useful measures in the prevention of AMS in pilgrims (Bartsch and Swenson, 2013). Pilgrims may walk barefoot (Sahota and Panwar, 2013) and may take holy dips in icy lakes (Shayka, 2004) at high altitude, which may predispose to hypothermia and altitude sickness (Hackett and Roach, 2001). Advice about proper footwear and warm clothes has to be emphasized, even if traveling in the summer months when the temperature may suddenly become very chilly, especially after sunset in the mountains. In addition adequate water consumption (2 to 3 L per day) to avoid dehydration may be important and should be discussed, especially with women and older pilgrims who intend to fast.

Pre-travel evaluation

Pilgrims with pre-existing problems such as diabetes, peptic ulcer disease, and coronary artery disease need to see a knowledgeable physician and obtain as much advice as possible regarding their illness and travel to high altitude, including the medical advisability of going on the high altitude pilgrimage (Mieske et al., 2010; Basnyat and Tabin, 2011) in their present condition. But at the same time, simply turning away the pilgrims (who often have a strong desire to make the pilgrimage) with these illnesses without proper assessment and optimal medical therapy is inadvisable. The list of medical problems and medications of the pilgrims needs to be properly written out in legible writing in English, Hindi, or Nepali (as the case may be) which the pilgrims need to carry in person. A simple, hand-held pulse oximeter may be useful in evaluating a pilgrim with the symptoms of altitude illness or to monitor pilgrims with cardiopulmonary problems, although pitfalls in their use need to be noted (Luks and Swenson, 2011). Finally, since pilgrimages are often a family journey, AMS prevention programs should be targeted both at parents and children.

Infection control

Infection control, which may help to avoid AMS as discussed above, should be given priority; a simple hand sanitizer may be very useful. Appropriate immunization, for example, influenza vaccinations to prevent the spread of respiratory infections in these large congregations, may be useful. Other travel vaccinations, because many pilgrims from abroad are VFRs (visiting friends and relatives) and potentially more prone to infections than other Western travelers, may need to be considered (Brunette, 2014). In addition to reaching high altitude areas, people may have to travel through areas of endemics of dengue and malaria (e.g., travel through New Delhi to reach Srinagar). Hence proper precaution against these diseases (insect repellents and malaria prophylaxis) should be considered (Basnyat et al. 2001; Basnyat and Ericsson, 2011).

Improved awareness of altitude illness by local health-care professionals

Increased awareness about prevention and management of altitude illness and related diseases in health professionals in this area has to be emphasized. For example, most of the health

camps along the way to the Gosainkunda Lake and the Shri Amarnath Yatra are staffed by health-care workers who may not know the basics of altitude sickness. Cylinders of oxygen may be impractical to stock in these camps for such a large congregation, but most of these camps do not have acetazolamide, corticosteroids, or nifedipine (the main altitude sickness drugs) (Basnyat and Murdoch, 2003) in their pharmacies. Importantly, very few if any health camps keep the handy hyperbaric bag (Basnyat, 2013), which may be life-saving in these austere settings where descent may not be immediately possible. These recommendations have been summarized in Table 2.

Conclusion

High altitude pilgrimage medicine generally centers on helping physically unfit individuals (frequently with co-morbidities) who may ascend too high too quickly, often with dangerous consequences. Future studies need to examine co-morbidities in this population more in detail and how these problems may adversely affect them at high altitude so that treatment can be effective. As health-care professionals, we do want to help the pilgrims on their high altitude pilgrimage so that they remain well during the journey and return home safely. But at the same time, we have to acknowledge that the pilgrimage is often a personal, spiritual journey with, as mentioned at the outset, suffering perceived to be an integral part of the trip. This latter mindset often hinders rescue efforts. Finally, many of these pilgrims are impoverished, and although we may make suggestions for warm clothing, reliable footwear, and other useful high altitude gear, these may not be financially feasible for them.

Author Disclosure Statement

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