ORIGINAL ARTICLE

Expedition health and safety: a risk assessment

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Little has been published on the risks of participating in an expedition. A questionnaire survey was conducted to quantify those risks and to determine how expedition organizers plan for medical mishaps.

246 expeditions, taking 2381 participants to more than one hundred countries, were studied retrospectively. 65 expeditions (26%) reported no medical incidents; the remaining 181 reported 835 in 130 000 man-days (6.4 per 1000 man-days). 59% of the medical incidents seen on expeditions were preventable, one-third of these being due to gastrointestinal upsets. 78% of medical incidents were classified as minor and only 5% (40) as serious. There was no excess of serious incidents in any particular organizational group or environment.

The findings of this survey suggest that the health risks of participating in a well-planned expedition are similar to those encountered during normal active life.

INTRODUCTION

Serious medical mishaps on expeditions are rare. Nonetheless, any medical condition becomes more difficult to manage in a remote area. An expedition may be defined as 'an organized journey or voyage for a specific purpose'[1]. Each year hundreds of expeditions leave the UK to visit remote parts of the world. They vary in size, duration and purpose but none can avoid the possibility of illness or injury. Most consist of a small group of individuals, often affiliated to a school, a university or the armed forces, but an increasing number are commercially organized. These expeditions commonly include young people with little experience of the environments they will encounter.

So far, little has been published to help individuals assess the risks of joining an expedition. In this paper we record how expeditions currently plan for medical incidents. We classify the types of incident that arise and quantify the risks of participation.

METHOD

Information on expedition health and safety was collected retrospectively from all expeditions known to the Expedition Advisory Centre (EAC) of the Royal Geographical Society (RGS), London. All expedition leaders were informed prospectively that medical data would be requested. The EAC distributed questionnaires in the spring of 1996, 1997 and 1998 to review expeditions that were in the field during 1995, 1996 and 1997. Each expedition was contacted once only, about six months after return to the UK; no further follow-up was conducted. The questionnaire was developed from one used by Johnson[2] in 1982 and from the incident reporting form of the Young Explorers Trust. It was divided into three parts. Part 1 sought information about the expedition, its purpose and activities, the type of terrain visited and the number, age and sex of the participants. Medical data collected included details of the expedition medical officers—whether they were doctors, nurses, paramedics or first-aiders—together with details of pre-expedition preparation and first-aid training. Part 2 requested details of medical incidents during the expedition and the treatment given. Respondents were asked to classify the medical incident according to its severity. An incident was defined as mild if the casualty was able to continue work after treatment, intermediate if the casualty was unable to continue working but was able to remain on the expedition, and serious if hospital admission, evacuation or death occurred. Part 3 of the questionnaire requested further details on incidents classified as serious in Part 2. Data were stored and analysed on a Microsoft Excel spreadsheet.

RESULTS

During the three-year study period 246 expedition leaders returned a completed questionnaire—response rate 36%. These expeditions took 2381 participants (68% male) to 105 countries and spent a total of nearly 19 000 days, or 130 000 man-days, in the field. 41% visited mountains, 33% the tropics, and 26% polar, desert, marine, and aquatic environments. 105 expeditions (43%) were associated with universities, 29 (12%) with schools, 12 (5%) with private companies and 10 (4%) with the

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armed forces. The remaining 90 expeditions (36%) were organized either by charities, such as British Schools Exploring Society or Brathay Expeditions, or by individuals. 35 (14%) of the expeditions included participants under the age of 18; these expeditions were generally larger than average, and this age group made up a quarter of the study. Expeditions ranged in size from 1 to 90, with a mean of 9 participants and a mode of 4 (49 expeditions). Their length varied from two weeks to over three months, the average being eight weeks. Half the expeditions lived in tents, 17% in huts and 25% in permanent structures. The main purposes of the expeditions studied were: scientific study 45% (111), adventure 39% (96), community work 2% (6) and mixed science and adventure 14% (33). This last group consisted mainly of youth expeditions. The age range and sex of expedition members are shown in Figure 1.

During preparation for the expedition, medical advice was obtained from general practitioners (47%), university health centres (21%), travel clinics (2%) and other experts (23%). 7% of expeditions sought no outside advice. Expedition medical cover was provided by a first-aider in 160 expeditions (65%), a doctor in 31 (13%), a nurse in 14 (6%) and a paramedic in 10 (4%). Some expeditions had several levels of medical cover. Only 31 expeditions (13%) had no participant with basic first-aid or medical training. Expedition members obtained first-aid training by attending a course run by the St John Ambulance in 20%, the Red Cross in 8%, and a commercial organization in 5%. 68% of participants thought their first-aid training had been worthwhile, 3% did not and 29% made no comment. 96% of expeditions had contingency plans for casualty evacuation and 95% of expeditions had taken out medical insurance.

Reported health hazards and medical incidents

65 expeditions (26%) reported no medical incidents; the remaining 181 reported a total of 835. 656 incidents (78%) were classified as mild, 139 (17%) as intermediate and 40 (5%) as serious. Incidents were divided into the seven categories listed in Table 1. The overall incident rate was 6.4 per 1000 man-days.

Gastrointestinal illness was the most common disorder in expedition members, causing one-third of all medical incidents. Diarrhoea and vomiting due to a variety of causes—bacterial dysentery, amoebic dysentery and food poisoning—were troublesome on 72 expeditions. Simple first-aid measures such as fluids and mild analgesics were usually effective; however, over the study period, treatment with quinolone antibiotics such as ciprofloxacin became increasingly popular.

Next after gastrointestinal disorders was the 'medical' category, contributing 21% of all incidents. This included chest, ear and skin infections, typhoid fever (3 cases), actual or suspected malaria (23), dengue (7) and drug related side-effects (16). Mefloquine (Larium) was the agent in 12 of the 16 drug-related side-effects: the usual complaints were dizziness, tiredness and vivid dreams, but one expedition member returned home with depression. All 23 individuals with malaria were successfully treated, in 16 cases by local doctors.

Next came the 'orthopaedic' category (17%). Purely orthopaedic troubles (22) were due to falls on rough terrain with minor knee and wrist injuries; most of these injuries were dealt with by first-aiders, although 2 required evacuation. 104 incidents involved trauma, including falls, burns, lacerations, bruises and concussion. Again the incidents were usually minor, but 11 people were involved in road traffic accidents and 1 in an avalanche; several people had serious falls in remote areas, including the Kalimantan rainforest and a glacier in Kyrgyzstan.

Troubles resulting from environmental conditions included heat exhaustion, heat stroke, frost-nip, frostbite (4) and acute mountain sickness (AMS). Of the 58 whose illnesses were related to altitude, 13 had the more severe forms of AMS, pulmonary and cerebral oedema; 11 of these needed to be evacuated. Acetazolamide and descent were

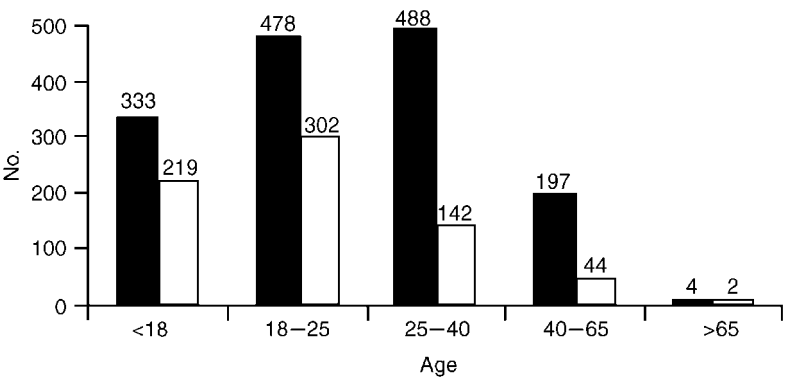

Figure 1 **Age of expedition members.** 171 not stated in expedition reports. ■Male; □ female

Table 1 **Incidence of expedition medical disorders**

Category	*Subcategory*	*No. of incidents*	*Incident total per category*	*Incidence per 1000 man-days*
Gastrointestinal	Gastrointestinal	275	275 (33%)	2.12
Medical	General medical	98	179 (21%)	1.38
	Malaria	23		
	Dengue fever	7		
	Skin	31		
	Pharmaceutical	16		
	Psychiatric	4		
Orthopaedic	Orthopaedic	22	142 (17%)	1.10
	Back	16		
	Trauma	104		
Environmental	Environmental	1	117 (14%)	0.90
	Sun/heat	40		
	Cold	13		
	Water	5		
	Altitude	58		
Fauna	Animal	19	63 (8%)	0.49
	Insect	44		
Feet	Feet	30	30 (4%)	0.23
Surgical	General surgical	6	29 (3%)	0.22
	Dental	10		
	Eye	13		
Total		835		6.44

the most common initial treatments. 19 incidents were caused by wildlife: scorpions stung 5 expedition participants, snakes bit 2, and jellyfish stung 3. Only 30 people had serious trouble with their feet. 'Surgical' disorders were rare—2 cases of appendicitis, 10 of mild dental trouble and 13 of conjunctivitis or mild trauma to the eye.

Of 206 expedition participants treated by a doctor, 94 were managed by a doctor on the expedition, 97 sought help from a local practitioner, 10 saw their own general practitioner on return to the UK and 5 were seen by UK hospital doctors.

5% (40) of expedition medical incidents were classified as 'serious' (Figure 2). These were mainly due to malaria but included the murder of 2 Indonesian members of an expedition to Irian Jaya who were kidnapped and held hostage by Papuan Independence Fighters for several months. These were the only deaths reported in the three-year study period of 2381 participants and 19 000 expedition days. Serious 'orthopaedic' problems were fractures and dislocations sustained in the mountains, none due to road accidents. There was no excess of 'serious' incidents in any particular organizational group or environment. The expeditions that reported 'serious' incidents had better medical cover than expeditions in general. 25 of the 40 people involved in a 'serious' incident required temporary or permanent evacuation; 11 of these were suffering from acute mountain sickness and were taken to lower altitude and 13 were admitted to hospital and treated by local doctors for malaria, dysentery, appendicitis and renal stones. 8 (0.3% of total expedition participants) had to be repatriated.

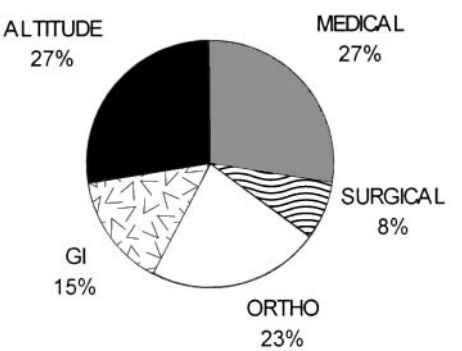

Figure 2 **'Serious' medical incidents (40) by category.** GI=gastrointestinal; ORTHO=orthopaedic

5 non-medical incidents with the potential to cause injury were reported, although none of those concerned came to harm. These were two narrowly-averted road traffic accidents, a mud-slide in Anatolia which flattened tents and destroyed equipment, a polar bear attack in Spitsbergen that was averted by preparatory defences erected around the campsite, and a sandstorm in the Gobi desert during which expedition camels escaped, leaving the expedition stranded for six days.

DISCUSSION

In 19 000 expedition days or 130 000 man-days only 835 medical incidents were reported. Thus, participation in an expedition is not a high-risk activity.

This study is the largest of its kind published to date. However, it does have limitations. Although the sample size is large, it still forms only a small proportion of the expedition market now estimated to involve between 12 000 and 15 000 travellers a year (Expedition Advisory Centre, RGS, personal communication). The response rate at 36% is low. Part of the reason for this is that submission of data was voluntary and therefore relied on the goodwill of expedition leaders in answering the questionnaire; secondly, only one contact was made with each expedition, because of time and resource limitations; thirdly, nearly half of all expeditions (43%) were organized by university students, who frequently change address; fourthly, about 5% of expeditions leave no contact address with the RGS; and, finally, a proportion of expeditions that register never travel. In addition we feel that there is a response bias, since responses are likely to be weighted towards expeditions with medical incidents, and that the data may under-represent minor medical problems as the questionnaire was completed six months post expedition. On closer inspection of several crude indicators it seems that respondents and non-respondents were similar, so this study is likely to be a better reflection of expedition medical troubles than the response rate of 36% might suggest.

Very little research has been published on the medical risks of joining an expedition. We conducted a search using the keywords 'expedition medicine', 'wilderness medicine', 'travel', 'accident' and 'risk' and found that most of the studies concerned non-remote locations and recorded death rates, for various activities, rather than less serious medical incidents. A satisfactory comparison of our results with published data is therefore difficult. One study reported on the risks of participating in an expedition in the early 1980s[2], while others reported on individual expeditions[3].

Leisure pastimes are never completely safe. In 1991, Campbell and O'Driscoll reported that leisure injuries in Scotland resulted in 285 000 new visits to casualty departments[4]. Nevertheless, our results indicate that participation in a well-planned expedition is comparatively safe, with a medical incident rate of 6.4 per 1000 man-days and a death rate of 1 per 1200 participants. Hodgetts and Cooke[5] quote a medical incident rate of 9 per 1000 at a 'rave', 10 per 1000 per day at a scout camp, 17 per 1000 at a rock festival and 28 per 1000 running a marathon. The risk of a medical incident on an expedition is therefore similar to that in other events in which young people commonly participate. According to Calman's classification[6], the risk of death on an expedition is 'low'.

Table 2 **Risk of death to participant**

Everest summit	16% (Ref. 7)
Himalayan mountaineering	2.9% (Ref. 8)
Antarctic over-wintering	1.0% (Ref. 9)
This study, all expedition types	0.083%*
Himalayan trekking	0.014% (Ref. 10)
Low altitude jogging	0.013% (Ref. 11)

*These were deaths in non-British participants

Table 3 **Frequency of death (per million days of exposure)**

Trekking in Nepal	11 (Ref. 10)
Austrian mountaineers	5.7 (Ref. 12)
English mountaineers	2.3 (Ref. 13)
Motoring in the USA	0.34 (Ref. 14)
Ball and water sports	0.02 (Ref. 13)

Risk of death

The risk of death on an expedition varies considerably according to type. High-altitude mountaineering is very dangerous, whereas treks at lower altitude are comparable in danger to other daily activities (Table 2). While Himalayan peaks and Antarctica in winter are visited by only a handful of people, attempts have been made to quantify the risk of death in other areas. Table 3 enumerates the likelihood of death per million days of exposure to a hazard. Such figures are inevitably inaccurate, as the exact number of participants is unknown—with the exception of Nepal where foreigners must purchase a trekking permit[10].

Avery, Harper and Ackroyd suggest that mountaineering is one hundred times more dangerous than ball games or water sports[13]. Deaths from jogging at low altitude have been estimated at 1 per 7620 joggers[11]. A paper published in 1995 stated that 'the risk of an Australian dying while travelling overseas is probably little different from that while staying at home'[15]. While vacation and business travel may involve less risk than an adventure trip, modern

expeditions keep risk to a minimum by participant selection, preparation and training.

Morbidity

A *BMJ* conference report in 1983 on expedition medicine[16] stated that the 'commonest cause of morbidity and mortality on expeditions is an accident, especially a road traffic accident, with tropical disease coming way down on the list'. Our study does not support that comment: only 11 people were involved in road traffic accidents while at least three times as many developed a tropical disease. The results presented in this paper show that gastrointestinal disorders are the most common cause of preventable expedition morbidity. This supports research published by the British Antarctic Survey[9] and by Johnson[2]. John Dallimore (personal communication), who undertook a prospective study in 1997 of youth expeditions, likewise found that gastrointestinal disorders made up nearly one-third of reported medical problems.

78% of medical incidents that occurred on expeditions were minor and 59% were avoidable. Avoidable incidents included gastrointestinal disorders, environmental problems and foot troubles. Chest infections, back strains and most minor injuries are as likely to occur at home as abroad. Increased attention to training in personal and food hygiene, awareness of environmental risks (heat exhaustion/altitude sickness) and the hazards posed by wildlife, both animal and insect, might further reduce morbidity. Malaria and dengue fever pose a serious risk to tropical travellers but malarial prophylaxis was also troublesome. Reports of drug-related side-effects became more common in 1995 when concerns about mefloquine were publicized.

Mountaineering expeditions are often considered to pose a special risk to participants[13]. 54 (21%) of the expeditions studied involved mountaineering. This sub-group reported 214 (25%) of all medical incidents. The excess associated with this type of expedition is small unless the aim is to reach extreme altitudes. Mountaineering expeditions had a much lower percentage of 'medical' problems, 11% compared with 21% for all expeditions, a slightly higher rate of gastrointestinal problems at 36% (versus 33%) and a much higher rate of environmental problems at 25% (versus 14%). Most of the environmental incidents were altitude sickness (17%), which could be lessened by education on the need for gradual ascent and acclimatization.

Youth expeditions

25% of all expedition participants were under 18. The expeditions they joined were bigger and had better medical cover than average; 50% took either a doctor or a nurse (compared with 19% of all expeditions). Young people are considered more vulnerable as they lack experience. Whereas in adult expeditions participants accept the risk for themselves, in youth expeditions parents as well as the participants are involved in assessing the risk of the trip. The evidence we have gathered shows that young people are at no greater medical risk than any other age group.

Pre-expedition preparation

Nearly all expeditions had sought medical advice before leaving and had purchased appropriate medical insurance. As judged by the study conducted in 1983 by Johnson[2],

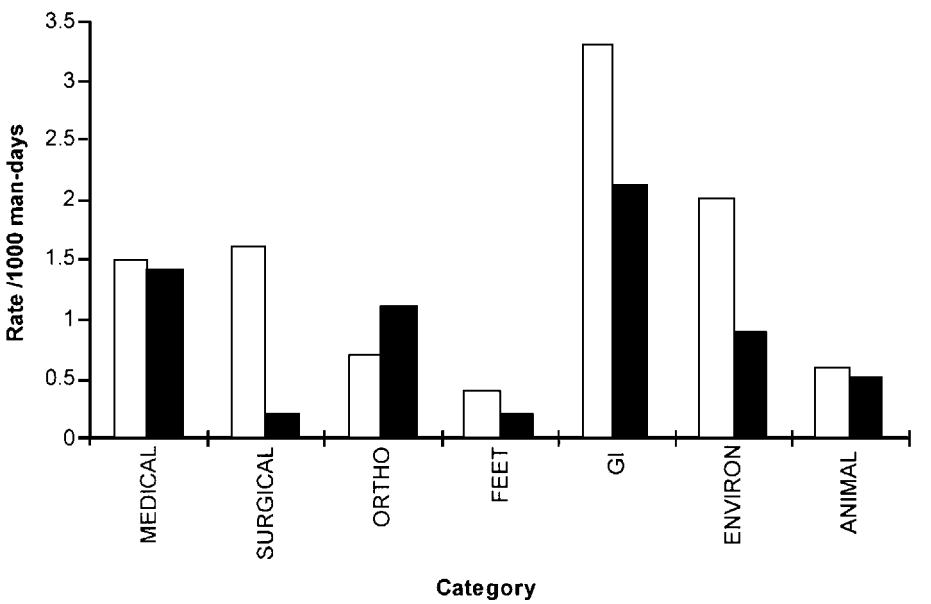

Figure 3 **Medical incidents, comparison between expeditions in 1983 and 1995–1997.** □1983; ■1995–1997; GI=gastrointestinal; ORTHO=orthopaedic

current expeditions are better prepared than those of fifteen years ago. Only 13% of contemporary expeditions lack a participant with basic first-aid or medical training, compared with 52% in 1983. Better preparation has reduced the medical incident rate from 10.1 to 6.4 per 1000 man-days. The most impressive reductions have been in the occurrence of gastrointestinal, surgical and environmental problems (Figure 3). Further improvements are possible.

Risk means different things to different people. In this paper risk is defined as the probability of a hazard or incident to cause harm[6]. Everything we do has an associated risk. Individuals perceive and react to risk differently. Anticipation, preparation and education reduce the probability that a hazard will become a risk. In summary, the findings of this study suggest that the health risks of participating in a well-planned expedition are similar to those encountered at home during normal active life.

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