

## ***WATER DISINFECTION METHODS EMPLOYED BY MOUNTAINEERS VISITING THE EVEREST AREA OF NEPAL***

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*Is there a correlation between those using unsafe methods and those contracting diarrhoea?*

### *Introduction*

Water disinfection can be difficult for mountaineers and, as trekking in Nepal becomes more popular, the risk of selecting contaminated water increases. Avoiding gastrointestinal (G.I.) infection, however, is of huge importance to mountaineers. Studies have indicated that mountaineers may suffer an altered immune system and impaired host defences when exposed to high altitude, making them more prone to infection [Meehan, 1987]. Diarrhoeal infection can also have a number of important adverse consequences at altitude. G.I. infection has been linked with an increased incidence of acute mountain sickness (AMS) [Murdoch, 1995] and is also known to increase dehydration. Dehydration, in turn can be linked with increased risks of hypothermia, frostbite, accidents [Wilkerson, 1992] and risk of blood clotting at altitude [Peacock, 1997].

The aims of this small-scale study were twofold; firstly to establish which methods of water disinfection are being used by mountaineers visiting this area. Secondly, to determine if there is a correlation between those using unsafe methods of disinfection and those contracting diarrhoea.

*Which methods of water disinfection are safe for these Mountaineers?*

### **Boiling**

Boiling is regarded as a reliable method of disinfection. Although water boils at a lower temperature at higher altitudes, the boiling temperature and the time required to reach that temperature, should be adequate to kill disease producing micro-organisms, including parasitic cysts, bacteria and viruses [Wilkerson, 1992; Neumann, 1997; Backer, 1996].

However, some problems with boiling do exist. Backer [1996] for example, recognises that there is concern over Hepatitis A virus (HAV) as it has increased thermal resistance. Consequently, some centres are still recommending boiling for one minute to allow for an extra margin of safety. Cyclospora has also been found in Nepal and are said to be heat stable [Philipp, 1992]. Any mountaineers that visit shortly after the monsoon, up until November, will need to take extra precautions with their water (see advice for mountaineers later).

Other recognised problems with boiling are not with its safety but its inconvenience and time consuming nature. Fuel must be carried, and if wood is used in the huts, this is obviously going to have effects on the local resources. One kilogram of wood is required to boil one litre of water [Chaudhuri, Saltar, 1990]. Even more wood may be required at altitude.

### *Chemical treatments*

Chlorine has been seen by many authors to be unreliable in a wilderness environment [Wilkerson, 1992; Ongerth, 1989; Garelick, 1992; Kahn, Visscher, 1975].

Silver is seen as less effective than other chemicals [Nomad pharmacy, 1996].

Iodine is often recommended as it is less affected by the pH and organic content of the water than chlorine. As with most chemical reactions, however, iodine's activity is slower in cold water. Contact time or concentration needs to be increased both in this case and also if the water is cloudy or coloured to compensate for the binding of the disinfectant to organic compounds [Wilkerson, 1992]. It seems apparent that further studies are needed on cold temperature use. Currently, recommendations on dosages and contact time vary, and it is impossible to detect if the water is potable after treatment in the wilderness.

There is also concern about the effects of continued iodine use on expeditions. In a large scale study cited by Wilkerson [1992] only those with previous thyroid problems were adversely affected. However, most of these study subjects were ingesting much lower doses of iodine than a mountaineer would, relying on this as the main method of water treatment on an expedition.

Unfortunately, little information is available on iodine's effects on Cyclospora. Cyclospora is, however, said to be resistant to iodine [Howarth, 1995]. Fortunately, mountaineers miss the worst of these pathogens, which are more prevalent in the lowlands from May to November. The mountaineering season may overlap slightly with the end of this risk period when the numbers of pathogens are likely to be decreasing. Iodine, if used with extra care e.g. filtering for murky water and during the high risk months, is regarded as a safe disinfectant.

### *Filtering*

Used in combination with a chemical disinfectant (preferably iodine), filters are beneficial, but are not generally recommended as a single step process. Filter manufacturers often make claims that have not been tested by impartial laboratories [Neumann, 1997]. It is also difficult to recognise when filters are damaged and no longer functioning effectively. As King [1992] stated, no uniform, objective, agreed, standards exist for such devices, and external safeguards are generally lacking. Filter pores are often too large to remove viruses. Although filters are improving, a healthy skepticism over manufacturers claims should be maintained.

## DESIGN AND IMPLEMENTATION

Twenty two mountain guides and independent mountaineers (i.e. those not on an organised climb with a trekking company) that had visited the Everest area of Nepal were sent a questionnaire. Four mountaineers / trekkers that had climbed some of the lower peaks above base camp height, 19 000 ft. were also interviewed over the phone using the same questionnaire (two of these were on organised treks.) Mountaineers were asked to answer the questions with regard to their most recent visit to the area. The sample was selected by two professional guides.

*Results*

In total 26 mountaineers were questioned and 19 responses were obtained (73% response rate.)

What methods of water disinfection are used by mountaineers to the Everest area?

One mountaineer stated that he did not treat any water in any way and relied totally on purchased drinks and did not suffer with watery diarrhoea that occurred more than three times a day.

*Boiling*

All of the other mountaineers (18) said that they had at some stage, boiled water to treat it.

On the trek in, a majority, 10 of the 18, claimed that they allowed their water to boil for a minute or more. Some mountaineers in this group, 4 in total, said they boiled their water for 5 minutes or more. Only 5 of the 18 (28%) simply brought their water to the boil (see Figure 1).

On the mountain peaks however, water disinfection methods were possibly more relaxed. Four of the mountaineers (22%) simply melted the snow and ice rather than allowing it to boil. Seven of the 18 mountaineers (39%) relied totally on boiling as their method of disinfecting the water. They did not carry chemical treatments or filters.

*Chemical treatments*

Eleven mountaineers (61%) also used chemical treatment methods. Only one person used a filter to back up this treatment. No mountaineers' stated that they used a filter as a single step treatment (see Figure 2).

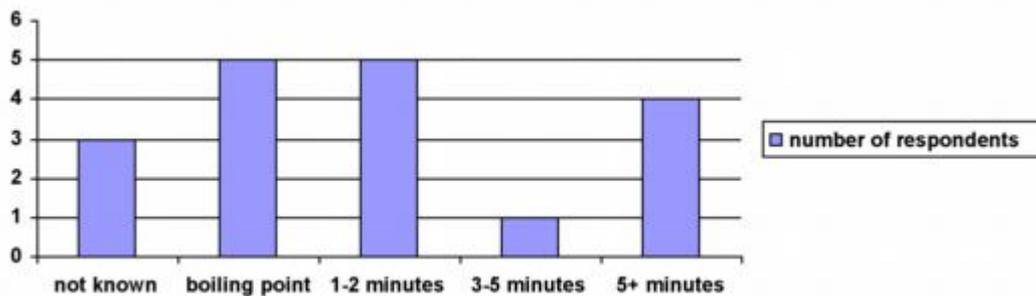


Figure 1: Boiling times used by the mountaineers on the trek in.

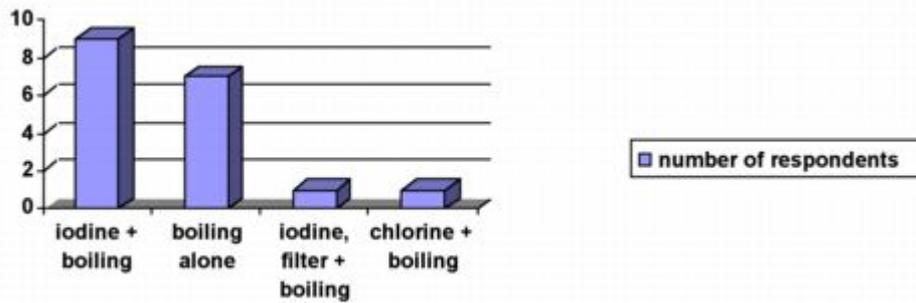


Figure 2: Water disinfection methods employed by the mountaineers

Out of the 11 people using chemicals (See Figure 3), one used iodine crystals, two used iodine tablets, eight used iodine liquid, one used chlorine. (One person was included twice in the above figures as he had used both iodine tablets and liquid).

*Is there a correlation between unsafe methods of water disinfection and those suffering with diarrhoea in these mountaineers?*

It was apparent that statistically, the sample was too small to make any statements on such a correlation. Some mountaineers had to be omitted from the calculations as they had used methods that were borderline between the safe and unsafe groups, others were not sure on the exact time and dosage used.

Four mountaineers were using unsafe methods (although many others guessed at unsafe regimes). The incidence of diarrhoea that occurred in this group while or just after they had treated the water was only 1 out of the 4 or, 25 % of this group.

The incidence of diarrhoea in the group using safe methods of disinfection was 50%, 4 out of the 8 were affected.

Out of all of the 19 mountaineers questioned, 47%, contracted travellers diarrhoea (TD, defined as watery diarrhoea that occurred more than three times a day). Five of those contracting TD commenced with their symptoms while in Kathmandu. Of this group, 4 had diarrhoea on arrival to the country, when only 2 were treating their own water (safe methods), the other two were relying on urchased drinks. Only 4 of the 9 had TD that started on the trek in or on the peaks.

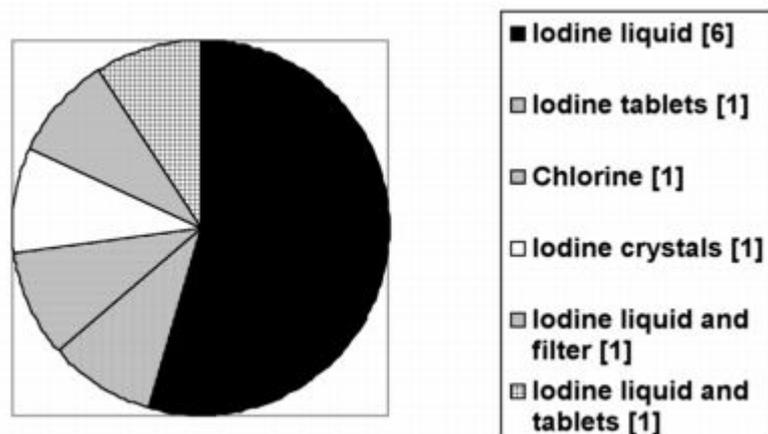


Figure 3: The chemical disinfectants used by the mountaineers

*Discussion and Recommendations*

The mountaineers in this study are mostly very experienced, their methods of water disinfection may not represent those used by a wider group of mountaineers. They may be using safer methods due to experience. They may also have stopped using chemicals for concerns over the continued, frequent use of these disinfectants.

However, the results of the study show some interesting points to be highlighted.

Surprisingly, a large number of mountaineers (39% of this group) relied totally on boiling. This may be due to the concerns over long term, continued, chemical treatment use. However, boiling alone can be inconvenient and time consuming especially for large quantities of water. Above 4,600-4900m fluid requirements often exceed 4 litres per day [Wilkerson, 1992], it could be questioned whether these mountaineers are actually drinking enough. With the low temperatures at altitude, this treatment would take some considerable time and much fuel must be carried and used. Four of the mountaineers actually stated that they boiled their water for 5 minutes or more, this must take up allot of fuel for this quantity of water.

Iodine was used by many of the mountaineers, 10 out of the 18 (55%). Liquid iodine was by far the most popular choice. Mountaineers, it seems, are aware that iodine is the safest of the chemical treatments. However, this popular choice of liquid iodine may not have been the best. Two studies have shown that the tincture of iodine is slower than the crystals and tablets at inactivating Giardia cysts [Ongerth, 1989; Jarroll et al, 1980]. A few authors have also stated that the tincture of iodine actually imparts more taste to the water than the other two options [Wilkerson, 1992]. It seems that the crystals have the least recognised disadvantages, yet only one of the mountaineers used this method. Crystals supposedly last longer and are therefore cheaper, than the other iodine treatments. They supposedly impart less taste to the water than the tincture and produce a less stinging solution for wound cleansing [Wilkerson, 1992]. It is apparent that mountaineers could benefit from further information on these crystals.

<u>Type of Chemical used</u>	<u>Method</u>
Iodine crystals (1 person)	Followed the instructions and thinks that he waited the recommended time but could not remember the time given or the dosage.
Iodine tablets (2)	1 used 1 tablet and left it for 20 minutes, 1 used 2 tablets and left it for 20 minutes.
Iodine liquid (8)	1 used 3-4 drops for 30 minutes, 1 used 5 drops for 20 minutes, 1 used 4 drops and left it 1 hour, 2 used 5 drops for 30 minutes, Three could not remember fully:- 1 used 1 drop for 20 minutes (but was not sure) 1 used 2-3 drops and waited the recommended time yet could not remember how long this was, 1 followed the dosage instructions but did not wait the recommended time, he did however, use a filter with

	silver (MSR waterworks)
chlorine (1)	Used 1 steretab for 30 minutes.

One significant concern that is highlighted from the mountaineers descriptions is the apparent lack of clear advice on the contact times and dosages needed to disinfect cold water. This problem is likely to affect a larger group of mountaineers. Nearly all of the group had used different regimes. More importantly, the results suggest that many of those using iodine were not doing so safely according to the recommendations for cold water [Garelick, 1992; Wilkerson, 1992; Neumann, 1997; Walker, 1997]. Of the seven that had remembered the dosage and contact time used, only 2 had at least doubled either the contact time or the dosage to compensate for the cold temperature of the water. More available, clear, information is obviously needed for these travellers' on chemically treating cold water.

The fact that only one of these mountaineers had used a filter with the chemical treatments was also surprising. This may be due to the filters receiving bad publicity from various travel medicine experts. A quality filter should be able to remove the parasitic cysts. These tend to be quite resistant to the iodine at small doses or short contact times. The two together, a filter and iodine, are certainly seen as an effective disinfection regime.

The study failed to achieve its second aim, investigating if there is a correlation between unsafe water and T.D. in this group. In this small sample, certainly no correlation was seen. However, due to the small sample size, these findings are not statistically significant.

Other findings not related to the aims and objectives can be found. The incidence of diarrhoea in this group was 47%. However, 60% of the cases of diarrhoea commenced during the stay in Kathmandu. Although some of these six mountaineers were disinfecting their water at this time, they were all using what would appear to be safe methods. It is more likely then that they picked up an enteric pathogen from a source other than their treated water.

Significantly, two had climbed with constant symptoms of infection, so at least some mountaineers were not aware of the available and effective treatments. Again, these were experienced people who were more likely to know about treatments than novices to the sport. Even one days worth of ciprofloxacin is said to greatly reduce GI infections [Neumann, 1996]. Although in normal circumstances it is not recommended to take antibiotics for TD, when troublesome symptoms persist for a long time antibiotics could be a sensible idea. This is especially so considering the additional risks to mountaineers of dehydration and infection. The common enteric pathogens in Nepal are all treatable by ciprofloxacin or metronidazole. [Neumann, 1996].

#### *Recommendations for mountaineers visiting Nepal.*

Boiling can be recommended to intending visitors to the area. However, it can be inconvenient and time consuming for large quantities of water especially when climbing. Another method to use when boiling is not practical or convenient, is chemical disinfection by iodine. Crystalline iodine appears to be the most

satisfactory of the various iodine options. Mountaineers must be aware that they need to at least double the standard contact times or dosage for cold water. Using a quality filter with this treatment is worthwhile, especially for murky water. Professional mountaineers or people relying on treated water regularly may be rightfully concerned about the effects of long term iodine use. Partially heating their water and /or filter use may allow these mountaineers to save fuel and reduce their iodine intake.

Mountaineers visiting Nepal between May and November should be aware of Cyclospora. Extra care with water disinfection should be recommended. Selecting running water rather than water from pools or mountain lakes and, using filters to remove particles is sensible.

With the risks to mountaineers of infection and dehydration being quite high, antibiotics are a sensible treatment option for troublesome, lasting, symptoms. Ciprofloxacin or Metronidazole would treat the majority of the pathogens prevalent in this area. Obtaining adequate verbal and written information on the use of these medications prior to the expedition is recommended. Mountaineers should be aware of the problems of infections and dehydration at altitude. Finally, as many of the mountaineers seem to contract TD in Kathmandu, warnings that extra precautions are needed here would be worthwhile. Discussion on the other factors that can cause TD would be useful.

### **Summary**

In a small group of experienced British mountaineers it was found that many (39%) are relying on boiling totally, to disinfect their water. Many of those mountaineers that also used chemical disinfection methods were not using sufficient contact times and dosages to treat the cold water. Further information is indicated for these mountaineers on the recommended contact times and dosages, the long term effects of regular iodine use, and the most effective yet convenient chemical treatment (possibly iodine crystals). The study failed to find a correlation between TD and those using unsafe methods of water disinfection. Limitations in the study's design and size however, suggest that these findings are not statistically significant. The results did suggest that mountaineers would benefit from more information on the use of antibiotics to treat troublesome GI infections.

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